SUGARBEET RESEARCH

1962 REPORT

Compiled by Sugarbeet Investigations

CROPS RESEARCH DIVISION
AGRICULTURAL RESEARCH SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

CR-4-63

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
Crops Research Division
Beltsville, Maryland

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1/ This is a progress report of cooperative investigations containing data, the interpretation of which may be modified with additional experimentation. Therefore, publication, display, or distribution of any data or statements herein should not be made without prior written approval of the Crops Research Division, ARS, U.S. Department of Agriculture, and the Cooperating agency or agencies concerned.

CR-4-63

FOREWORD

Sugarbeet Research is an annual compilation of research accomplishments by staff members of Sugarbeet Investigations and Cooperators.

The Report serves as a medium of presenting results of investigations that have been strengthened by contributions from the Beet Sugar Development Foundation and as a means of reporting research accomplishments under Cooperative Agreements between Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, and the Beet Sugar Development Foundation; the Farmers & Manufacturers Beet Sugar Association; and Union Sugar Division, Consolidated Foods Corporation.

Research on virus yellows at Salinas, California, has been strengthened through contributions from the California Beet Growers Association, Limited.

Some of the investigations reported by staff members of Sugarbeet Investigations, as well as field tests reported by Cooperators, have not been supported by the Beet Sugar Development Foundation or other cooperating agency; therefore, a Foundation Project number or a credit statement on a title page should not be construed as meaning that all investigations received support from the agency mentioned.

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HIGHLIGHTS OF ACCOMPLISHMENTS

New Inbred Lines and Breeder Seed.--The American varieties of sugarbeet are now characterized by monogerm seed which was only a genetic character a few years ago. The new inbred lines and breeder seed proposed for increase and utilization in 1961 and 1962 were prevailingly monogerm, with the multigerm sorts relegated to the role of pollinators or as sources of desirable germ plasm.

During 1962, Sugarbeet Investigations made available to the Beet Sugar Development Foundation 15 new developments in breeding research under provisions of a Memorandum of Understanding. The items proposed for seed increase and utilization have been described on pages 7-11. The plan of utilization of the items by members of the Foundation is given on pages 12-14. Small quantities of seed of most of the items proposed for increase were supplied to members of the Foundation, thereby permitting company breeders to explore the potential value of the items in their breeding programs.

Seed productions in 1962 of items proposed for seed increase in 1961 are given on page 15. Descriptions of the items proposed for seed increase and utilization in 1961 are given on pages 7-12 of the 1961 Report.

Through the Beet Sugar Development Foundation, 13 additional special items of breeding material developed by the staff of Sugarbeet Investigations were supplied to plant breeders of sugar companies.

Monogerm Seed Production.--The development of monogerm varieties of sugarbeet suitable for the American grower has been a noteworthy accomplishment in which all agencies of sugarbeet research such as government, industry, and seed producing enterprises have made significant contributions. Grower demand for the new seed that facilitates mechanization of field operations has accelerated the research activity.

Sugarbeet seed productions for 1955 through 1962, given on page 16, were taken from AGRICULTURAL STATISTICS, USDA. A striking increase in the production of monogerm seed will be noted for the 8-year period. From an initial production of only a few bags in 1955 the percentage of monogerm seed has shown a progressive upward trend, and the sugarbeet seed crop of 1962 was 88.5 percent monogerm. This is a remarkable achievement! A complete change to monogerm varieties may be attained in 1963 for the major portion of sugarbeet acreage.

It is of interest to compare the development and use of monogerm varieties of sugarbeet with the acceptance of hybrid corn. In SEEDS, 1961 Yearbook, U.S. Department of Agriculture, it is stated that the first commercial hybrid corn seed for sale in any quantity was produced in Iowa in 1926. Seven years later (1933), hybrid varieties were grown

on about 1 percent of the corn acreage in the Corn Belt. Complete acceptance of hybrid corn in the Corn Belt was not attained until 1955, or a period of 22 years was required from 1 percent use to complete acceptance.

It has been contended that the acceptance of hybrid varieties was greatly influenced by the tendency of hybrid corn to remain erect and thereby facilitate mechanical harvest. Similarly, the eager acceptance of monogerm varieties of sugarbeet was greatly influenced by the urgency for complete mechanization of all field operations in sugarbeet production.

Field Tests to evaluate regional adaptation of seven monogerm varieties in the Great Lakes region are given in Part IV. The summary prepared by G. J. Hogaboam and H. W. Bockstahler is given on page 99. The commercial monogerm hybrid SL 122MS X SP 5460-0, which is widely used in the Great Lakes region, did not differ significantly from the multigerm standard, SP 5481-0, in any of the attributes given. In general, the new monogerm varieties gave the same level of performance, indicating that progress is being made in the development of monogerm varieties as replacements for the multigerm variety SP 5481-0, or US 401. However, it is recognized that further improvement of monogerm varieties is needed with respect to disease resistance, yield, and quality.

The mean gross sugar of the three-way monogerm hybrid (515 X 569) X NB7 which was produced by J. S. McFarlane, was 9 percent above that of US H6 in the California tests.

Evaluations of varieties carrying resistance to leaf spot and curly top are reported by J. O. Gaskill in Part V. In the tests summarized on page 157, the triploid monogerm hybrid, SL 128MS X US 401(4n), gave the best average performance. This same triploid hybrid gave excellent root yield in tests conducted in Michigan and Ohio (p. 118), as did other hybrids in which tetraploid US 401 was used as pollinator.

The root yield of monogerm three-way cross SL 1101 was statistically above other entries in the Logan test (p. 75) reported by G. K. Ryser.

Polyploidy.--Cytological investigations--notably those of Helen Savitsky, G. E. Coe, B. L. Hammond, and R. J. Hecker--have established several inbred lines and varieties on the tetraploid level. These tetraploid sorts have been used in hybridizations, as well as in field tests, to appraise the influence of ploidy levels on productivity and disease resistance.

The results of field tests with triploid, diploid, and tetraploid hybrids and their diploid and tetraploid parents are given in Part IV by V. F. Savitsky. These same parental lines and hybrids were evaluated in Utah in 1960. The results of the 2 years at two locations showed general concordance of performances. It is evident for these tests that 2n♀ X 4n cross tended to be unlike its reciprocal in root yield.

It is also pointed out that the root yield of tetraploid US 35/2 and US 104 was greater than that of their parental diploid parent. In general, the sucrose percentage was enhanced by tetraploidizations. It is significant that tetraploid US 401 has shown curly top resistance, whereas the diploid parent suffers serious damage from the disease.

An array of triploid hybrids arising mostly from hybridizations of diploid male-sterile lines of J. S. McFarlane with the tetraploid pollinators received from Hilleshög Sugar Beet Breeding Institute, Landskrona, Sweden, and Bush Johnsons Limited, Maldon, England, have been evaluated under California conditions. In the 1961 and 1962 tests, none of the triploid hybrids performed significantly better than the best diploid hybrids. The mean sugar yield for triploid US H2 was not significantly different from that of diploid US H2.

Techniques and Procedures.--Applications of gametocides FW-450 and FW-676 to flowering sugarbeets by I. O. Skoyen (p. 57) brought about 80 percent hybridization between self-fertile NB1 and a red beet. Untreated plants of NB1 produced only 0.5 percent hybrids with the red beet. In the tests FW-450 was more effective than FW-676.

Eight tetrazolium salts were tested by R. J. Hecker as a vital stain for sugarbeet pollen (p. 201). The results indicate that one of the salts provided a specific and rapid means of determining viability of mature sugarbeet pollen.

Owen and Ryser (1959 Report) isolated a pollen restorer gene from US 201. The occurrence of a more potent pollen restorer gene in a garden beet has been demonstrated by J. C. Theurer and G. K. Ryser (p. 63).

A rapid method of evaluating individual sugarbeets for chemical constituents is presented by Theurer, Stout, and Ryser (p. 66). They found that after field selections for root size and shape the refractometer can be used effectively to eliminate roots that are undesirable with respect to other chemical constituents.

Application of Principles in Sugarbeet Breeding.--LeRoy Powers has shown that utilization of specific combining ability should bring about a decided improvement in the eight characters under study. The research reported in Part VI indicates that hybrid populations of sugarbeet are more likely to combine many desirable characters than the nonhybrid populations.

A study of the response of the sugarbeet to date of harvest, as measured by yield and quality, indicated that populations can be bred which may be harvested 1 month earlier than presently grown commercial varieties and still produce satisfactory yield of roots, percentage sucrose, and percentage apparent purity.

Virus Disease Investigations.--The occurrence of yellowing of young sugarbeet plants, illustrated on page 283, has been reported by C. W. Bennett for California, Oregon, and Washington. Attempts to

transmit a virus from affected plants have been unsuccessful, and no evidence has been obtained to indicate that yellowing is caused by an infectious agent. Although the yellowing has been confused with virus yellows, the symptoms are distinctly different. The affected seedlings recover in later stages of development.

Bennett has isolated strains of the mosaic virus that differ strikingly in virulence as well as in symptom expression. The difference in virulence of two strains of the virus on sugarbeet is illustrated on page 286.

Further development of a chemical test to identify plants that are resistant to the yellows virus is reported by J. M. Fife (p. 292). The results of a field test indicate that selections for resistance to the virus may be more effective if based on both root size and magnitude of amino acid ratio in mature leaves of infected plants.

Breeding for Resistance to Virus Yellows.--Root size of plants in populations of sugarbeets infested with the yellows virus, as well as the relative reduction in root yield induced in lines by virus inoculations, has been used by McFarlane, Bennett, and Skoyen as a primary criterion of tolerance. Three years of successive selection from US 75 has resulted in a resistance level equal to that of resistant lines received from European breeders. It is of interest that McFarlane (pages 19 and 304-308) observed unexpected tolerance to virus yellows in monogerm hybrid 539H1 and that V. F. Savitsky (p. 223) reported similar differential response to virus yellows among polyploid strains.

Breeding for Nematode Resistance.--Progress has been made by Charles Price (Part VIII) in the development of lines of sugarbeets that are tolerant to the cyst nematode *Heterodera schachtii* and to other soil-inhabiting pathogens comprising the field inoculum used in the research. The striking tolerance of two new lines in greenhouse tests is illustrated on pages 253 and 254. The outstanding lines in the greenhouse tests were included in a field test illustrated on page 252. The soil in the field is heavily infested with the nematode. Under the conditions of the field test the root yield of most of the new lines was strikingly greater than that of either US 41 or US 75. Plant survival of the new lines under field conditions was equally gratifying and tended to reflect their performances in the greenhouse.

The first backcross generation of hybridizations of the sugarbeet (*Beta vulgaris*) and species of the section Patellaris were evaluated for resistance to the cyst nematode by Helen Savitsky and Charles Price (pages 243, 247). Seedlings from the interspecific hybridizations were discarded if the root system was heavily infested with *Heterodera schachtii*. Following the third exposure to the nematode, the investigators retained a choice group of 15 plants with only 1 to 6 female nematodes on the root of each. A second group of 9 plants, with a higher incidence of nematodes than the choice group but with fewer than the discarded plants, was also retained. None of the seedlings was found to remain free of nematodes in these tests. It is significant that Steele and Savitsky (p. 277) found one female nematode on each of two plants of *Beta patellaris*.

Nematology Investigations.--The results of research conducted by A. E. Steele, Nematology Investigations, and associates, Charles Price, J. M. Fife, and Helen Savitsky, Sugarbeet Investigations, are given in Part IX. Steele and Price found marked reduction in cysts of *Heterodera schachtii* in microplots of infested soil after 1 year of cropping with legumes, but there was virtually no further reduction in cysts per gram of soil following the second year of cropping with the same leguminous plants.

Steele and Fife found that the sugarbeet root diffusate, which stimulates hatching of the nematode, can be concentrated by evaporation or freezing with no measurable loss in activity. They also found no appreciable change in hatching activity for solutions ranging from pH 4 to pH 7.

Steele and Savitsky reported finding one adult female of *H. schachtii* on each of two plants of *Beta patellaris*. One female contained eggs that were developing. These eggs were used to inoculate a plant of *B. patellaris*, and 60 days later one adult female and four brown cysts were found. In their inoculation tests, *B. corolliflora*, *B. intermedia*, *B. lomatogona*, *B. macrorhiza*, and *B. trigyna* were heavily infected with *H. schachtii*.

Curly Top Investigations and Breeding for Resistance.--A new facility for field evaluations for curly top resistance has been established by A. M. Murphy at Thatcher, Utah. Many breeding lines and experimental hybrids developed by sugarbeet breeders in Sugarbeet Investigations (p. 80) and in research departments of sugar companies have been effectively evaluated for curly top resistance. Currently the research efforts of C. L. Schneider (p. 85) are being devoted to development of greenhouse techniques to effectively appraise the curly top resistance of individual plants as well as inbred lines.

Physiological Investigations.--In experiments conducted by F. W. Snyder (p. 323) with plants of US 401 and 62B1x05, the leaf area in August correlated with either root weight or total plant weight at harvest. However, the leaf area measurements in June did not correlate significantly with either root weight or total plant weight at harvest.

Various spray treatments of indoleacetic acid did not induce significant differences; and except for 25 ppm, all treatments tended to reduce sugar percentage.

In preliminary tests with respiratory inhibitors, Myron Stout (p. 92) found that one chemical reduced respiration rate, one increased respiration rate, and the others had little or no effect on rate of respiration.

Rhizoctonia Investigations.--Under moderately severe disease exposure, SP 611107-0, developed by J. O. Gaskill, was outstanding in 1962 comparisons between progenies of plants selected for resistance to *Rhizoctonia solani* and their respective unselected parents, thereby supporting the results obtained under somewhat more severe exposure in 1961.

Several accessions of *Beta maritima* and exotic forms of *B. vulgaris* were evaluated for resistance to *Rhizoctonia solani* in greenhouse tests. Under conditions of these tests none demonstrated measurable resistance.

PART I

NEW DEVELOPMENTS IN BREEDING RESEARCH

Items Proposed for Seed Increase 1962
and
Utilization and Distribution of Items

- - - - -

Seed Production of 1961 Items

PRODUCTION OF MONOGERM SEED IN U.S.A.

NEW DEVELOPMENTS IN BREEDING RESEARCH

Items Proposed for Seed Increase
May 23, 1962

Breeder seed, inbred lines, and hybrid varieties, developed in breeding research conducted by the staff of Sugarbeet Investigations, are proposed for seed increase through the Beet Sugar Development Foundation. Seed not needed for planting overwintering plots will be furnished on request to company members of the Foundation for utilization in their breeding programs. Brief descriptions, current designations, and estimates of seed available August 1 are given for the items.

These new products of breeding research have been developed in work conducted under Cooperative Agreements with:

Colorado Agricultural Experiment Station
Michigan Agricultural Experiment Station
Minnesota Agricultural Experiment Station
New Mexico Agricultural Experiment Station
Utah Agricultural Experiment Station
Beet Sugar Development Foundation
Farmers & Manufacturers Beet Sugar Association
Union Sugar Division, Consolidated Foods Corp.

Items Proposed for Seed Increase and Utilization

I. U.S. Agricultural Research Station, Salinas, California.

A. Developments in breeding research by J. S. McFarlane and associates:

Item 1. C2563 Monogerm - - - - - - - - - - - - - - 5 pounds

A curly-top-resistant selection from the C0562 inbred. C0562 was selected from a cross between NB1 and the bolting-resistant C8507 monogerm inbred. Greenhouse tests show C2563 to possess resistance to curly top strain No. 11 equal to the resistance of NB1. C2563 is a good type-O and is expected to have good bolting resistance.

Suggested utilization: (a) Increase C2563 and its male-sterile equivalent (Item 2); and (b) produce F_1 hybrids, using 569HO and 546HO as seed-bearing parents.

Item 2. C2563HO Monogerm - - - - - - - - - - - - - - - 5 pounds

A male-sterile monogerm derived from the second backcross to C2563. MS of NB1 was the source of male sterility. The curly top resistance of C2563HO is expected to be similar to that of C2563.

Suggested utilization: Use C2563HO as the seed-bearing parent in the production of the male-sterile equivalent of C2563 (Item 1).

Item 3. C2563H1 Monogerm - - - - - - - - - - - - - - - 5 pounds

An F_1 monogerm hybrid between MS of 569 and C2563. This F_1 hybrid is expected to have curly top resistance approaching that of MS of NB1 X NB3. Bolting resistance and male sterility should also be good.

Suggested utilization: Use the F_1 as a male-sterile monogerm parent in the production of experimental quantities of 3-way hybrids.

B. Developments in breeding research by Helen and V. F. Savitsky:

Item 4. S-23 Diploid Monogerm - - - - - - - - - - - - - 200-300 grams

A self-fertile inbred line that is high in bolting resistance, good in sucrose percentage, and recessive for hypocotyl color (rr). This inbred line was very high in leaf spot resistance in tests conducted by J. O. Gaskill

Item 5. S-71 Diploid Monogerm - - - - - - - - - - - - 200 grams

A self-sterile line that is curly top resistant and good in sucrose percentage. This line contains a high percentage of plants that do not restore pollen fertility when mated with male-sterile plants.

Item 6. S-201 Tetraploid Multigerm - - - - - - - - - - 1 pound

A self-sterile line that is good in curly top resistance, very vigorous, has large multigerm seed, and is good in pollen production.

Suggested utilization: Use as tetraploid pollinator to obtain triploid hybrids and to determine combining ability in triploid hybrids.

Item 7. S-202 Tetraploid Multigerm - - - - - - - - - - 1 pound

A self-sterile line that is good in curly top resistance, very vigorous, has large multigerm seed, and is good in pollen production. This line is late in reaching flowering stage.

Suggested utilization: Use as tetraploid pollinator with diploid male-sterile lines to obtain triploid hybrids that are resistant to curly top. The late flowering of the line makes it suitable as a pollinator for male-sterile phases of bolting-resistant lines.

Item 8. S-301 Tetraploid Monogerm - - - - - - - - - - - - 300 grams

A self-fertile monogerm inbred line that is moderate in resistance to curly top and bolting, good in vigor, and has shown good combining ability in preliminary tests.

II. Crops Research Laboratory, Logan Utah.

Item 9. SL 14500 Monogerm Annual - - - - - - - - - - - - 1 pound

A pollinator that has been further improved as type-O. See Item 9 on pages 8 and 15 of Sugar Beet Research, 1961 Report.

Item 10. SL 14500HO Monogerm Annual - - - - - - - - - - - - 1 pound

The male-sterile phase of SL 14500 (see Item 9). For further information, see Item 9 on pages 8 and 15 of Sugar Beet Research, 1961 Report.

III. Plant Industry Station, Beltsville, Maryland.

Item 11. SP 6223-0[1] Monogerm - - - - - - - - - - - - 1 pound

An inbred line with slight deviations from perfect type-O, which is good in leaf spot resistance and moderate in black root resistance. The combining ability of the male-sterile equivalent (see Item 12) is being tested in field trials in 1962.

1/ See footnote to Item 12.

Item 12. SP 6223-01(MS)[1/] Monogerm - - - - - - - - - - 2 pounds

The male-sterile equivalent of SP 6223-0 (see Item 11).

1/ Two related type-0 monogerm lines, SP 6224-0 and SP 6225-0, are being tested for disease resistance, etc., and checked for completeness of type-0 condition. The line most attractive August 1 will be made available for seed increase and utilization.

IV. SUPPLEMENT - U.S. Agricultural Research Station, Salinas, California

A. Developments in breeding research by J. S. McFarlane and Associates:

Item 13. C264 Multigerm - - - - - - - - - - - - - - - - 3 pounds

An increase of a bolting-resistant selection from C663 which is the pollen parent of US H2, US H5b, and US H6. (See Sugar Beet Research, 1960 Report, p. 136, and Jour. Amer. Soc. Sugar Beet Technol. 11(6): 500-506, 1961.)

Suggested utilization: Seed increase of C264 for use as pollen parent in production of hybrids with high degree of bolting resistance.

Item 14. C2549 Monogerm - - - - - - - - - - - - - - - - 2 pounds

A monogerm inbred with very good bolting resistance and moderate curly top resistance. This inbred is not completely Type O but should yield male-sterile progeny when crossed with a good male sterile such as 562HO. C2549 represents an increase of an F_3 selection from a cross between the bolting-resistant 507 and NB6 inbreds. It is a bolting-resistant sister line of C1546 which was made available in 1961. (See Item 12, Sugar Beet Research, 1961 Report.) Combining ability determined from two tests in Imperial Valley is good.

Suggested utilization: (a) Small seed increase of C2549, and (b) production of F_1 hybrid using C2549 as pollen parent and 562HO as seed-bearing parent. (For C0562 and C0562HO, see Items 12 and 13, Sugar Beet Research, 1960 Report.)

B. Developments in breeding research by Helen and V. F. Savitsky:

Item 15. S-133 Diploid Multigerm Janasz - - - - - - - - - 12 grams

Seed of the high sucrose variety, Janasz (Polish), used as parental stock by Drs. Helen and V. F. Savitsky in the development of tetraploid S-203 (see Item 16).

Item 16. S-203 Tetraploid Multigerm Janasz - - - - - - - 1 pound

A self-sterile tetraploid strain high in sucrose; obtained after colchicine treatment of diploid S-133 by Drs. Helen and V. F. Savitsky. S-203 is good in vigor and in pollen production. Triploid hybrids obtained by using S-203 as pollinator with male-sterile diploids show (June 1962) good vigor in field trials.

Suggested utilization: (a) Seed increase of S-203; (b) use S-203 as tetraploid pollinator with male-sterile diploid monogerm lines to produce triploid hybrids with high sucrose percentage.

BEET SUGAR DEVELOPMENT FOUNDATION
P. O. BOX 538
FORT COLLINS, COLORADO

UTILIZATION OF USDA SEED RELEASES, 1962

ITEM NUMBERS AND SEED NUMBERS ARE IDENTICAL WITH THOSE LISTED IN THE RELEASE MEMORANDUM DATED MAY 23, 1962 AND ITS SUPPLEMENT DATED JUNE 29, 1962 1/

I. U. S. AGRICULTURAL RESEARCH STATION, SALINAS, CALIFORNIA.

A. DEVELOPMENTS IN BREEDING RESEARCH BY J. S. MCFARLANE AND ASSOCIATES.

ITEM 1. C2563 MONOGERM

OF THE AMOUNT AVAILABLE, SMALL AMOUNTS FOR TESTING WILL BE DISTRIBUTED NOW AS FOLLOWS: GREAT WESTERN - 10 GRAMS; AMERICAN CRYSTAL - 25 GRAMS; UTAH-IDAHO - 25 GRAMS; SPRECKELS - 10 GRAMS; UNION - 25 GRAMS; HOLLY - 25 GRAMS AND WANTS STECKLINGS FROM THE INCREASE.

THE BALANCE OF THE QUANTITY RELEASED IS TO BE INCREASED BY THE WEST COAST BEET SEED COMPANY AND UTILIZED AS SUGGESTED ON A PROPORTIONATE SHARE BASIS BY THE FOLLOWING COMPANIES: F & M; GREAT WESTERN; AMERICAN CRYSTAL; HOLLY; SPRECKELS; UNION.

ITEM 2. C2563HO MONOGERM

DISTRIBUTION AND UTILIZATION WILL BE IDENTICAL WITH THAT NOTED ABOVE FOR ITEM 1.

ITEM 3. C2563H1 MONOGERM

THE FIVE POUNDS AVAILABLE WILL BE DISTRIBUTED ON A PROPORTIONATE SHARE BASIS TO THE COMPANIES LISTED AS FOLLOWS: F & M; GREAT WESTERN; AMERICAN CRYSTAL; HOLLY; UTAH-IDAHO; SPRECKELS; UNION.

B. DEVELOPMENTS IN BREEDING RESEARCH BY HELEN AND V. F. SAVITSKY.

ITEM 4. S-23 DIPLOID MONOGERM

NO INCREASE WILL BE MADE. THE AVAILABLE QUANTITY WILL BE DISTRIBUTED TO THE COMPANIES LISTED AS FOLLOWS: AMERICAN CRYSTAL - 50 GRAMS; HOLLY - 25 GRAMS; UTAH-IDAHO - 15 GRAMS; SPRECKELS - 10 GRAMS; UNION - 10 GRAMS.

1/ MEMORANDUM TO JAMES H. FISCHER FROM DEWEY STEWART WITH SUBJECT "PROPOSALS FOR SEED INCREASE AND UTILIZATION."

Item 5. S-71 Diploid Monogerm

No increase will be made. The available quantity will be distributed to the companies listed as follows: F & M - 10 grams; Great Western - 25 grams; American Crystal - 25 grams; Holly - 25 grams; Utah-Idaho - 25 grams; Spreckels - 10 grams; Union - 10 grams.

Item 6. S-201 Tetraploid Multigerm

This seed will be utilized as suggested. The available seed will be distributed now on a proportionate basis to the companies listed as follows: F & M; Great Western; American Crystal; Holly; Utah-Idaho; Amalgamated; Spreckels; Union.

Item 7. S-202 Tetraploid Multigerm

This seed will be utilized and distributed to the same companies and on the same basis as for Item 6, above.

Item 8. S-301 Tetraploid Monogerm

This seed will be utilized and distributed to the same companies and on the same basis as for Items 6 and 7, above.

II. CROPS RESEARCH LABORATORY, LOGAN, UTAH.

Item 9. SL 14500 Monogerm Annual

With the exception of 10 grams each to Great Western, American Crystal and Amalgamated now, the entire seed production will be used to increase to a maximum quantity a supply to be used by the companies listed as follows: F & M; Great Western; American Crystal; Holly; Utah-Idaho; Amalgamated; Union. Increase to be made by the USDA at Logan.

Item 10. SL 14500HO Monogerm Annual

Same utilization as for Item 9 above excepting the addition of Spreckels to receive 10 grams now and their proportionate share of the increase to be made by the USDA at Logan, Utah.

III. PLANT INDUSTRY STATION, BELTSVILLE, MARYLAND.

Item 11. SP 6223-0 (or SP 6224-0 or SP 6225-0, whichever is most attractive on August 1).

From the available quantity, the companies listed will want the amounts shown now: Great Western - 50 grams; American Crystal - 25 grams; Utah-Idaho - 25 grams; Spreckels - 10 grams. Holly will want stecklings from the increase and 50 grams from the two numbers not selected for increase.

The balance of the seed will be used for an increase by the West Coast Beet Seed Company to be shared on a proportionate share basis by: F & M; Great Western; American Crystal; Holly; Spreckels.

Item 12. SP 6223-01(MS) (or SP 6224-0 or SP 6225-0, whichever is most attractive on August 1).

Distribution and utilization will be identical with that noted for Item 11, above.

IV. SUPPLEMENT - U. S. AGRICULTURAL RESEARCH STATION, SALINAS, CALIFORNIA.

Item 13. C264 Multigerm

Approximately one pound of the available quantity will be used for a 1/10-acre increase by the West Coast Beet Seed Company for the following companies to be shared on a proportionate share basis: American Crystal; Holly; Spreckels; Union. Spreckels wants stecklings from the increase.

Approximately 1/2 pound each will be sent now to: American Crystal; Holly; Spreckels; Union.

Item 14. C2549 Monogerm

Of the available seed, 25 grams will be sent now to each of the following companies: Great Western; American Crystal; Holly; Spreckels; Union.

The balance of the seed will be used for a 1/10-acre increase and utilization by the West Coast Beet Seed Company for the following companies to be shared on a proportionate share basis: American Crystal; Holly; Spreckels; Union. Spreckels wants stecklings from the increase.

Item 15. S-133 Diploid Multigerm Janasz

Because of the limited quantity of seed, none will be distributed at this time. The available seed will be planted by Great Western Sugar Company in Phoenix and stecklings will be planted in a Colorado isolation. Spreckels wants a few stecklings from Phoenix. Participation in this increase will probably be by all companies since the original sharing could not be met from the limited seed available.

Item 16. S-203 Tetraploid Monogerm Janasz

From the available quantity, 10 grams will be sent to each of the companies as follows: F & M; Great Western; American Crystal; Holly; Utah-Idaho; Amalgamated; Spreckels; Union. Spreckels wants stecklings from the increase.

The balance will be used for increase by the West Coast Beet Seed Company for the above listed companies on a proportionate share basis.

July 20, 1962
62-22
WMF

1962 Seed Productions of 1961 Proposals for Seed Increase
(See 1961 Report, pp. 7-13)

1961 Items	Breeder Seed Description	1962 Seed Production
1	CT5 (BC_1) Monogerm	None
2	CT5 (BC_1) MS Monogerm	None
3	CT5 (BC_2) Monogerm	Failed to overwinter
4	CT5 (BC_2) MS Monogerm	Failed to overwinter
5	SLC 132 Monogerm	None
6	SLC 132-0 (aa) Monogerm	None
7	SL 14460 (SLC 03) Multigerm	USDA at Logan
8	SL 14460HO(MS) Multigerm	USDA at Logan
9	SL 14500 (annual) Monogerm	USDA at Logan
10	SL 14500HO(MS) Monogerm	USDA at Logan
11	US 104 (tetraploid) Multigerm	None
12	C1546 Monogerm	F62-546 (WC lot 2481)
13	C163T (tetraploid) Multigerm	American Crystal Sugar Co.
14	FC 501 Monogerm	None
15	SP 6121-0 Monogerm	None
16	SP 6121-01(MS) Monogerm	None
17	SP 6161-0 Monogerm	American Crystal Sugar Co.
18	SP 6162-0 Monogerm	American Crystal Sugar Co.
19a	SP 60195-01 Monogerm	American Crystal Sugar Co.
19b	SP 60194-01 Monogerm	Great Western Sugar Co.
20	EL 61B18-0 Multigerm	None
21	EL 61B28-01 Multigerm	Great Western Sugar Co.
22	EL 59B18-01 Monogerm	None
23	EL 61G1-01 do	do
24	EL 61G1X02(MS)do	do
25	EL 61G2-01 do	do
26	EL 61G2-02(MS)do	do
27	EL 61G4-01 do	do
28	EL 61G4X02(MS)do	do

SUGARBEET SEED PRODUCTION IN UNITED STATES, 1955-1962

Year of production	100-pound bags			Percent monogerm
	Total	Multigerm	Monogerm 1/	
	bags	bags	bags	
1955	114,187	114,152	35 2/	Trace
1956	88,279	84,991	3,431	3.9
1957	94,547	83,812	10,735	11.4
1958	109,832	82,571	27,261	24.8
1959	111,788	83,594	28,194	25.2
1960	124,545	49,869	74,676	60.0
1961	95,541	25,227	70,314	73.6
1962	93,322	10,686	82,636	88.5

1/ Mostly from hybridizations in which the pollen parent was multigerm.

2/ Mostly foundation seed; but includes a production of 1,430 pounds of an experimental hybrid. The first appreciable quantity of commercial monogerm seed was produced in 1956.

P A R T II

DEVELOPMENT AND EVALUATION
of
INBRED LINES AND HYBRID VARIETIES OF SUGARBEETS SUITABLE FOR CALIFORNIA
and
STUDIES ON POLYPLOIDY

Foundation Projects 24 and 29

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Cooperators conducting tests:

American Crystal Sugar Company
Holly Sugar Corporation
Spreckels Sugar Company
Union Sugar Division
Southwestern Irrigation Field Station

REPORT ON FOUNDATION PROJECTS 24 AND 29
1962
Summary of Accomplishments

PERFORMANCE OF NEW MONOGERM MALE-STERILE PARENTS--One of the more important functions of the USDA sugarbeet breeding program at Salinas is to provide male-sterile parents which combine resistance to bolting and to disease. Current emphasis is being placed on the development of monogerm male steriles which perform as well or better than do multigerm parents such as NB1 x NB3 and NB1 x NB5.

Results with monogerm lines made available in 1960 and 1961 are encouraging. The F_1 combination, MS of 562 x 546, offers promise of being a high performing male-sterile parent. The hybrid, (562 x 546) x 663, performed as well or better than did US H6 from the standpoint of both root yield and sucrose percentage. The bolting and curly top resistance of 562 x 546 have not been checked but are expected to be a little inferior to those of NB1 x NB5, the male-sterile parent of US H6.

The inbred 562 and its male-sterile equivalent were made available in 1960 and are currently being used as parents in commercial hybrids. 546 was made available in 1961 and stock seed of 562 x 546 is being produced. Stock seed increases of other male-sterile F_1 combinations such as 562 x 569, 546 x 569, and 515 x 562 are also being produced.

PERFORMANCE OF THE MONOGERM HYBRID 539H1--The new monogerm hybrid 539H1 with the parentage (515 x 569) x NB7 gave a very good performance in 1962. In 11 coastal area tests, the gross sugar of 539H1 averaged 109 percent and the sucrose percentage 99 percent of US H6. In 2 Imperial Valley tests, the gross sugar of 539H1 averaged 103 percent and the sucrose percentage 105 percent of US H6. Incomplete results are available from the Central Valley. The US H6 variety, which was used as a basis of comparison in the 1962 tests, produced a gross sugar yield averaging 117 percent of US 75 in 63 coastal and Imperial Valley tests conducted between 1956 and 1961.

In 17 California tests conducted in 1959, 1960, and 1961, the gross sugar yield of 539H1 averaged 123 percent and the sucrose percentage 103 percent of US 75.

The curly top resistance of 539H1 equals that of US 75. Irregular results have been obtained on bolting resistance. In the 1961 test at Salinas and in 1961 and 1962 tests at Tracy, the bolting resistance of 539H1 was similar to that of US H6. In 1962, this hybrid bolted 14 percent in a December planting at Salinas and was more susceptible than any of the other US hybrid varieties included in the test. A discussion of this bolting problem may be found in the section of this report entitled "Effect of Season on Bolting Resistance". (See page 42.)

Results of tests at Salinas and Davis indicate that 539H1 may have some resistance to yellows. In both tests, 539H1 tended to have more resistance than did US 75. In the Davis test, 539H1 showed significantly less damage from the combination of beet and western yellows than did either US 75 or US H6. This resistance may have contributed to the outstanding performance of 539H1 in the 1962 coastal area tests.

A problem has been experienced in producing stock seed of MS of 515 x 569 and has caused a delay in the large-scale production of 539H1 seed. Fortunately, Mr. S. C. Campbell reports that the 1962-63 increase of this male sterile looks promising at Salem, Oregon.

SEED LOTS MADE AVAILABLE THROUGH THE FOUNDATION--A curly-top-resistant monogerm inbred, C2563, was made available in 1962. This type O inbred was selected from an S_2 population of the cross NB1 x 507 mm. Greenhouse tests showed C2563 to possess resistance to curly top virus strain 11 equal to that of NB1. In a field test at Thatcher, Utah, C2563 showed very good curly-top resistance but was slightly inferior to NB1. Bolting resistance of this inbred is superior to that of NB1.

The male-sterile equivalent of C2563 was also made available. This male-sterile represents the second backcross of C2563 to the MS of NB1. A small quantity of F_1 seed of the cross MS of 569 x C2563 was distributed for use in producing test quantities of 3-way hybrids.

C164, a bolting-resistant selection from C663 was made available for increase. This selection showed a significant improvement in bolting resistance over C663 in a November planting at Salinas. The curly top resistance of the selection is similar to that of C663. C164 is suggested as a possible replacement for the top-cross parent C663 in hybrids requiring high bolting resistance. (See page 44.)

A bolting-resistant monogerm designated C0549 may help fill the need for additional bolting resistance in monogerm hybrids. C0549 is an increase of an F_3 selection from a cross between the bolting-resistant 507 and NB6 inbreds. It is a bolting-resistant sister line of C1546 which was made available in 1961. C0549 is not completely type O but should yield male-sterile progeny when crossed with good male steriles such as the MS of 562. Tests at Salinas and Tracy with (562 x 0549) x 663 showed that this hybrid has bolting resistance similar to that of US H6.

BOLTING RESISTANCE--The 1961-62 growing season was favorable for the induction of bolting at Salinas, and resistance information was obtained on a large number of hybrid combinations and inbred lines. Low temperatures persisted throughout the summer and bolting induction continued until harvest. Differences were observed among hybrids and inbreds in the amount of bolting occurring at progressive dates during the growing season. None of entries in a November 13, 1961, planting at Salinas remained completely vegetative, but 2 monogerm inbreds showed less than 2-percent bolting. USDA bolting-resistant varieties bolted from 13 to 52 percent in the November test demonstrating the need for additional bolting resistance.

The 1962 tests as well as those of previous years show that the relative bolting resistance of varieties and inbreds is influenced by seasonal environmental conditions. Differences in year to year bolting behavior are greater in hybrids made up entirely of inbred components than in the more heterozygous top-cross hybrids. The relative bolting resistance of varieties and inbred lines is often different at Salinas, Tracy, and in Oregon. A need exists for a clearer understanding of the factors responsible for bolting induction and of the relationship between genotype and these factors.

CURLY TOP RESISTANCE--The termination of the curly top resistance evaluation and selection program at Jerome, Idaho, has made it necessary to consider other facilities and methods for obtaining resistance. During the past two years work has been underway in cooperation with Dr. C. W. Bennett to develop a greenhouse selection technique. Plants were grown in six-inch pots (four plants to the pot) and inoculated with strain 11 virus. Selections were made in segregating self-sterile and self-fertile populations based on relative freedom from curly top symptoms. Progeny tests of selections from these inoculated plants gave rather disappointing results. Selections from self-sterile populations in which the plants were allowed to interpollinate showed little or no improvement over the parent strains. Selections from self-fertile populations in which the progeny seed was massed likewise showed little improvement. The resistance of individual plant progenies of selections from self-fertile populations varied widely. Some progenies were more resistant than the parent and others more susceptible.

Results of the 1961-62 tests indicate that the degree of resistance can be reasonably accurately determined in the greenhouse. It is doubtful, however, whether much improvement can be made in resistance unless seed is saved from individual plants and the progenies evaluated separately.

POLYPLOIDY--Triploids between diploid male steriles and European tetraploids failed to perform significantly better than did diploid hybrid varieties in tests at Salinas, Brawley, King City, and Santa Maria. Triploids involving tetraploids from Bush Johnson Limited in England were high in tonnage but tended to be inferior in sucrose percentage. Triploids involving tetraploids from the Hilleshog Sugar Beet Breeding Institute in Sweden tended to be inferior in root yield but equal to the best diploid hybrids in sucrose percentage. (See page 47.)

Triploid US H2, (MS of NB1 x NB3) x 663(4n), produced a gross sugar yield averaging 6.7 percent higher in 8 tests than did the gross sugar yield of diploid US H2. The sucrose percentage of the triploid averaged 0.3 percentage points lower than did that of the diploid. Triploid US H2 tended to be superior to diploid US H2 in bolting resistance but inferior in curly top resistance.

The curly top resistance of tetraploids produced by Dr. Hammond from 2 self-sterile and 3 self-fertile diploids was similar to the resistance of the corresponding diploids. The test was made in the greenhouse with plants inoculated by Dr. Bennett with curly top virus strain 11.

Germination of triploid seed produced at Salem, Oregon, between diploid male steriles and 663 (4n) was low. Germination percentages determined from greenhouse tests were 64 and 76 percent for 2 multigerm hybrids and 21 and 45 percent for 2 monogerm hybrids. Low germination was not associated with either a shortage of pollen or a poor match between male sterile and pollinator.

Dr. Hammond produced additional tetraploids of self-sterile and self-fertile multigerm lines and of self-fertile monogerm lines. Tetraploids of a multigerm male sterile and a monogerm male sterile were also produced. The male sterility of the C_1 tetraploid generations was good. A summary of the progress in producing tetraploids, prepared by Dr. Hammond, is included in this report. (See page 53.)

Even though triploids involving European tetraploids have not shown superior performance in USDA tests, the possibility of developing superior triploids through the use of tetraploids from adapted American diploids should not be ruled out. Triploid hybrids are being produced from tetraploids developed by Dr. Hammond. Most of these hybrids will utilize tetraploids as the pollen parents. A few hybrids will also be produced, using a male-sterile tetraploid as the seed-bearing parent.

SUMMARY TABLES OF HYBRID PERFORMANCE--During the past several years, tables showing the performance of hybrids expressed in percent of the performance of US 75 have been made a part of this report. US 75 is inferior to all US hybrid varieties in gross sugar yield and sucrose percentage and is no longer being grown extensively as a commercial variety. Beginning this year, US H6 will be used as a basis of comparison in the summary tables. US H6 not only performs well from the standpoint of yield and sucrose percentage but also has wide adaptation. A summary of the performance of US H6 expressed in the percent of the performance of US 75 in 1956-61 variety tests follows:

	No. of tests	Gross sugar yield	Sucrose percentage
Coastal Valleys	40	117	104
Central Valley	11	120	104
Imperial Valley	23	117	101
	74	117	103

A hybrid which performs better than US H6 can be considered to be very good.

Gross sugar yields of bolting-resistant hybrids in 1962
California variety tests, expressed in percent of the yield of US H6

Location	Testing Agency	US H6	US H2	US H5	163H4 mm	163H5 mm	163H6 mm	163H7 mm	163H8 mm	1539H1 mm	1539H2 mm
Coastal Area											
Salinas - Nov. plt.	USDA	100	99	106	88	103	95	112	107	111	106
Salinas - Dec. plt.	"	100	87	97	97	-	97	109	104	107	96
King City	Union	100	104	-	97	99	99	-	-	114	-
Betteravia	"	100	104	101	-	91	97	108	97	99	-
Watsonville	"	100	90	93	-	87	91	99	92	99	-
Spreckels - Test 1	Spreckels	100	-	98	91	-	99	-	-	115	105
Spreckels - Test 2	"	100	-	97	90	92	87	-	-	121	112
Alisal	"	100	-	99	95	-	-	-	-	109	-
San Juan-Hollister	"	100	-	-	104	-	-	-	-	110	-
Hollister	"	100	-	-	-	-	-	-	-	109	-
King City	"	100	-	-	95	-	-	-	-	103	-
Imperial Valley											
Brawley - Early	USDA	100	106	-	92	89	96	105	104	102	-
Brawley - Late	"	100	93	-	88	90	91	103	97	103	-
Imp. Val. - Early	Holly	100	105	-	-	-	-	-	-	-	94
" " "	"	100	105	-	-	-	-	-	-	-	101
" " "	"	100	99	-	-	-	-	-	-	-	98
" " - Late	"	100	102	-	-	-	-	-	-	-	106
" " "	"	100	99	-	-	-	-	-	-	-	105
" " "	"	100	96	-	-	-	-	-	-	-	98
Central Valley											
Five Points	Spreckels	100	95	92	122	129	112	-	-	99	-
Clarksburg	Am. Crystal	100	-	-	103	100	103	-	-	99	102

Description of monogerm hybrids:

163H4---(515HO x 561) x 663
163H5---(515HO x 569) x 663
163H6---(515HO x 562) x 663
163H7---(562HO x 546-36) x 663
163H8---(562HO x 546-8) x 663
1539H1---(515HO x 569) x NB7
1539H2---569HO x NB7

Sucrose percentage of bolting-resistant hybrids in 1962
California variety tests, expressed in percent of US H6

Location	Testing Agency	US H6	US H2	US H5	163H4	163H5	163H6	163H7	163H8	1539H1	1539H2
Coastal Area											
Salinas - Nov. plt.	USDA	100	100	99	97	102	104	108	102	102	105
Salinas - Dec. plt.	"	100	94	96	100	-	100	100	102	101	-
King City	Union	100	99	-	99	101	99	-	-	99	-
Betteravia	"	100	102	107	-	98	101	104	104	91	-
Watsonville	"	100	98	99	-	99	99	101	100	95	-
Spreckels - Test 1	Spreckels	100	-	96	99	-	99	-	-	99	101
Spreckels - Test 2	"	100	-	101	102	95	100	-	-	101	98
Alisal	"	100	-	97	96	-	-	-	-	101	-
San Juan-Hollister	"	100	-	-	103	-	-	-	-	99	-
Hollister	"	100	-	-	-	-	-	-	-	102	-
King City	"	100	-	-	101	-	-	-	-	97	-
Imperial Valley											
Brawley - Early	USDA	100	100	-	99	98	103	100	102	107	-
Brawley - Late	"	100	95	-	100	98	99	97	97	103	-
Imp. Val. - Early	Holly	100	102	-	-	-	-	-	-	-	104
" " "	"	100	99	-	-	-	-	-	-	-	103
" " "	"	100	99	-	-	-	-	-	-	-	104
" " - Late	"	100	103	-	-	-	-	-	-	-	105
" " "	"	100	98	-	-	-	-	-	-	-	106
" " "	"	100	100	-	-	-	-	-	-	-	104
Central Valley											
Five Points	Spreckels	100	98	98	105	99	100	-	-	102	-
Clarksburg	Am. Crystal	100	-	-	103	101	104	-	-	100	102

VARIETY TEST, SALINAS, CALIFORNIA, 1962

Location: Spence Field of the U. S. Agricultural Research Station.

Soil type: Sandy loam.

Previous crops: Fallow, 1959; barley cover crop, 1960; vetch cover crop, 1961.

Fertilizer used: 600 lbs. per acre 10:10:5, preplant.
210 lbs. per acre ammonium sulfate sidedressed March 12, 1962.
170 lbs. per acre ammonium sulfate sidedressed May 14, 1962.

Planting date: Bolting test planted November 13, 1961.
Yield test planted December 14, 1961.

Thinning date: Bolting test, January 3, 1962.
Yield test, February 22, 1962.

Harvest date: Bolting test, August 30, 1962.
Yield test, October 1-3, 1962.

Irrigations: Sprinkler irrigation as required up to April 25, 1962. Subsequently, furrow irrigation used at about ten-day intervals.

Diseases and insects: Infection with yellows viruses approached 100 percent by mid-May. Test plots were sprayed twice with Dylox plus brown sugar for the control of leaf miner. Other diseases and insects were not factors in the 1962 tests.

Experimental design: Randomized block with four replications for the November 1961 planting. Varieties planted in two-row plots; plots 30 feet long. Ten varieties planted in a 10 x 10 latin square, with plots 55 feet long, for the December 1961 planting. Varieties planted in two-row plots with rows spaced 28 inches apart.

Sugar analysis: From two ten-beet samples per plot by Spreckels Sugar Company, Spreckels, California.

VARIETY TEST, SALINAS, CALIFORNIA, 1962

(4 replicated plots of each variety)

Planted: November 13, 1961
Harvested: August 30, 1962

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Harvest Count Number
163H7	(562HO x 546-36) x 663	10,431	34.3	15.3	27.4	160
F60-554H1	(MS of NB1 x NB4)	10,391	38.0	13.7	17.9	158
1539H1	(515HO x 569) x NB7	10,370	36.1	14.4	51.8	160
0546-22H1	85HO x 546-22	10,183	33.8	15.1	22.8	145
163TH2	(MS of NB1 x NB3) x 663 Tetra	10,002	37.4	13.4	18.1	135
163H8	(562HO x 546-8) x 663	9,964	34.7	14.4	17.9	163
063H3	US H5	9,888	35.2	14.0	25.7	168
1539H2	569HO x NB7	9,842	33.3	14.8	35.6	167
163H5	(515HO x 569) x 663	9,576	33.3	14.4	47.1	168
1547H1	(MS of NB1 x NB5)	9,567	32.1	14.9	16.7	175
164	Bolt. res. sel. 663	9,424	33.6	14.1	8.1	140
0546-36H2	85HO x 546-36	9,409	32.2	14.6	9.6	173
163H2	US H6	9,326	33.5	13.9	27.2	170
163H2a	US H6 (New)	9,321	33.1	14.1	23.1	173
063H1	US H2	9,244	32.8	14.1	37.2	155
163TH1	(515HO x 569) x 663 Tetra	9,212	35.2	13.1	29.8	105
F61-569H3	562HO x 569	9,211	30.9	14.9	31.6	140
163T	Tetraploid 663	9,207	36.8	12.5	20.1	138
0546-8H2	85HO x 546-8	9,095	30.7	14.8	13.9	153
165	Bolt. res. sel. 663	9,046	33.2	13.6	8.2	147
F60-547H1	(MS of NB1 x NB5)	9,010	30.4	14.8	28.9	155
163H6	(515HO x 562) x 663	8,859	30.2	14.7	34.5	163
087H1	(MS of NB5 x NB6) x F58-87	8,852	31.8	13.9	13.1	152
F60-512H1	(MS of NB5 x NB6)	8,589	30.4	14.2	10.6	153
663	NB, CT sel. (US 15 x US 22/3)	8,341	31.3	13.3	15.3	153
163H4	(515HO x 561) x 663	8,239	30.2	13.7	34.4	155
F61-561H1	569HO x 561	8,177	27.1	15.1	39.9	145
368	US 75	8,104	28.5	14.2	18.1	155
F61-569H2	561HO x 569	7,414	25.4	14.6	38.4	157
General MEAN of all varieties		9,251	32.6	14.2	24.9	Beets per 100' row
S. E. of MEAN		421	1.23	0.33	2.82	
Significant Difference (19:1)		1,182	3.45	0.92	7.93	
S. E. of MEAN in % of MEAN		4.55	3.77	2.29	11.30	

Odds 19:1 = 1.989 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose	Percent Bolting
Between varieties	28	2,212,537	34.06	1.71	544.13
Between replications	3	1,471,756	30.13	1.27	19.51
Remainder (Error)	84	708,229	6.04	0.43	31.80
Total	115				
Calculated F value		3.12**	5.64**	4.02**	17.11**

** Exceeds the 1% point of significance (F=1.94)

VARIETY TEST, SALINAS, CALIFORNIA, 1962

(9 replicated plots of each variety)

Planted: December 14, 1961
Harvested: October 1-2, 1962

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Harvest Count Number
163H7	(562H0 x 546-36) x 663	10,696	38.6	13.8	4.3	125
1539H1	(515H0 x 569) x NB7	10,496	37.9	13.9	13.8	126
163TH2	(MS of NB1 x NB3) x 663 Tetra	10,267	38.0	13.5	3.8	123
163H8	(562H0 x 546-8) x 663	10,242	36.4	14.1	2.6	124
163H2	US H6	9,891	35.3	14.0	5.8	127
163H2a	US H6 (New)	9,846	35.7	13.8	5.9	124
163H6	(515H0 x 562) x 663	9,535	34.5	13.8	8.6	128
063H3	US H5	9,517	35.7	13.3	5.9	124
163H4	(515H0 x 561) x 663	9,517	34.4	13.8	8.0	126
General MEAN of all varieties		10,001	36.3	13.8	6.5	Beets
S. E. of MEAN		295	0.92	0.21	0.79	per
Significant Difference (19:1)		832	2.58	N.S.	2.23	100'
S. E. of MEAN in % of MEAN		2.9	2.8	1.5	12.2	row

Odds 19:1 = 1.998 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose	Percent Bolting
Between varieties	8	1,774,429	21.60	0.49	99.11
Between replications	8	1,639,320	15.55	0.55	17.61
Remainder (Error)	64	780,765	7.54	0.40	5.65
Total	80				
Calculated F value		2.27*	2.86**	N.S.	17.54**

* Exceeds the 5% point of significance (F=2.08)
** Exceeds the 1% point of significance (F=2.79)

VARIETY TEST, BRAWLEY, CALIFORNIA, 1961-62

Location: U. S. Department of Agriculture, Southwestern Irrigation Field Station.[1/]

Soil type: Holtville silty clay loam.

Previous crops: Grain sorghum and sweet sorghum, 1960; Sesbania species cover crop, 1961.

Fertilizer used: 80 lbs. per acre P_2O_5, preplant.
80 lbs. per acre nitrogen, actual, preplant.
120 lbs. per acre nitrogen, actual, sidedressed November 15, 1961.

Planting date: September 28, 1961.

Thinning date: October 20, 1961.

Harvest dates: Early harvest, April 24-25, 1962.
Late harvest, June 4, 1962.

Irrigations: Early harvest, five, plus 1.40 inches rain.
Late harvest, seven, plus 1.40 inches rain.

Diseases and insects: Curly top and yellows viruses were of minor importance in the 1961-62 test. The test plot received applications of 10 percent DDT dust on October 6, 15, and 20, and on November 3, and 14, 1961 for control of cabbage beetle and several species of looper worms. The early harvested tests received an application of 5 percent Thimet granules at the rate of 20 lbs. per acre on January 15, 1962. The late harvested test received an additional application of 5% Thimet granules on April 5, 1962, at the rate of 20 lbs. per acre, for the control of aphid and spider mite.

Experimental design: Ten varieties planted in a 10 x 10 latin square, two-row plots; and a randomized block test with ten replications, single-row plots, for early harvest. Ten varieties planted in a 10 x 10 latin square, two-row plots, for late harvest. Rows were spaced 30 inches apart. Plots 40 feet long.

Sugar analysis: From two ten-beet samples per plot by Holly Sugar Corporation, Brawley, California.

Remarks: Test designed and results analyzed by the United States Agricultural Research Station, Salinas, California.

1/ Plot under supervision of K. Beatty stationed at Southwestern Irrigation Field Station, Brawley, California.

VARIETY TEST, BRAWLEY, CALIFORNIA, 1962

(10 x 10 Latin Square)

Planted: September 28, 1961
Harvested: April 24, 1962

Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
063H1	US H2	7,730	25.7	15.1	138
163H7	(562H0 x 546-36) x 663	7,650	25.3	15.1	138
163H8	(562H0 x 546-8) x 663	7,610	24.7	15.4	138
1539H1	(515H0 x 569) x NB7	7,470	23.3	16.1	138
163H2	US H6	7,420	24.4	15.2	142
163TH2	(MS of NB1 x NB3) x 663 Tetra	7,370	25.9	14.3	128
163H2a	US H6 (New)	7,310	24.1	15.1	138
163H6	(515H0 x 562) x 663	7,050	22.8	15.6	142
163H4	(515H0 x 561) x 663	6,750	22.7	14.9	138
163H5	(515H0 x 569) x 663	6,490	21.9	14.8	142
General MEAN of all varieties		7,280	24.1	15.2	Beets
S. E. of MEAN		137	0.45	0.18	per
Significant Difference (19:1)		385	1.26	0.51	100'
S. E. of MEAN in % of MEAN		1.88	1.86	1.19	row

Odds 19:1 = 1.99 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	9	1,643,142	18.48	2.18
Between replications	9	830,747	4.69	6.85
Between columns	9	783,492	5.69	1.20
Remainder (Error)	72	187,807	2.00	0.32
Total	99			
Calculated F value		8.74**	9.24**	6.72**

** Exceeds the 1% point of significance (F=2.64)

VARIETY TEST, BRAWLEY, CALIFORNIA, 1962

(10 x 10 Latin Square)

Planted: September 28, 1961
Harvested: June 4, 1962

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Harvest Count Number
163H7	(562HO x 546-36) x 663	10,551	35.5	14.9	0.7	115
163TH2	(MS of NB1 x NB3) x 663 Tetra	10,551	38.1	13.9	0.4	109
1539H1	(515HO x 569) x NB7	10,533	33.9	15.5	0.3	113
163H2a	US H6 (New)	10,200	34.0	15.1	0.4	114
163H2	US H6	10,118	35.0	14.5	1.2	113
163H8	(562HO x 546-8) x 663	9,848	33.7	14.6	0.4	116
063H1	US H2	9,458	33.2	14.3	3.9	116
163H6	(515HO x 562) x 663	9,269	30.9	15.0	1.0	113
163H5	(515HO x 569) x 663	9,163	31.4	14.8	2.3	114
163H4	(515HO x 561) x 663	8,958	29.6	15.1	1.4	115
General MEAN of all varieties		9,865	33.5	14.8		Per 100' of row
S. E. of MEAN		204	0.84	0.18		
Significant Difference (19:1)		573	2.35	0.50		
S. E. of MEAN in % of MEAN		2.1	2.5	1.2		

Odds 19:1 = 1.99 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	9	3,777,280	48.22	2.22
Between replications	9	2,530,444	16.37	5.24
Between columns	9	1,857,912	9.79	5.54
Remainder (Error)	71	415,287	6.98	0.32
Total	98			
Calculated F value		9.10**	6.91**	6.98**

** Exceeds the 1% point of significance (F=2.67)

VARIETY TEST, CLARKSBURG, CALIFORNIA, 1962

(6 replications of each variety) By American Crystal Sugar Co.

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Harvest Count
		Pounds	Tons	Percent	Number
1539H3	(561-3HO x 561) x NB7	7,556	24.36	15.51	123
163H4	(515HO x 561) x 663	7,457	23.75	15.70	126
163H6	(515HO x 562) x 663	7,435	23.59	15.76	128
1539H2	569HO x NB7	7,350	23.85	15.41	123
163H2	US H6	7,224	23.81	15.17	121
163H5	(515HO x 569) x 663	7,199	23.42	15.37	122
1539H1	(515HO x 569) x NB7	7,152	23.62	15.14	107
Am #2 H1	(MSNB1 x NB3) x 56-407-0	6,655	22.56	14.75	125
Am #5 NB	Commercial 58-205-0	6,608	22.57	14.65	110
General MEAN		7,177	23.57	15.27	121
LSD 5%		815	--	0.47	Beets
LSD 1%		--	--	0.63	per
Calculated F value		--	NS	6.58**	100'
C. V. %		9.60	9.24	2.59	row

** Exceeds the 1% point of significance (F=2.70)

Cooperator: Gemignani Bros.
Location: Grand Island
Planted: April 4, 1962
Harvested: September 10-11, 1962
Experimental design: 9 x 6 randomized block. Plot test C.

VARIETY TEST, KING CITY, CALIFORNIA, 1962

Grower and location: A. S. Duarte, King City, California.

Soil type: Salinas clay.

Previous crops: Tomatoes, 1959; peas and lettuce, 1960; lettuce, 1961.

Fertilizer used: 300 lbs. per acre 16:20:0, preplant
1000 lbs. per acre ammonium sulfate split into two sidedress applications of 500 lbs. each.

Planting date: March 5, 1962.

Thinning date: April 11, 1962.

Harvest date: October 15-17, 1962.

Irrigations: Five.

Diseases and insects: Infection with yellows viruses was fairly general throughout the 1962 test plot. Curly top virus also caused moderate damage in susceptible triploid test varieties. Leaf miner infestation was heavy in August and caused moderate damage to leaf blades and petioles. Nematode damage was light throughout 1962 test plot.

Experimental design: One test of ten varieties planted in a 10 x 10 latin square; and a test of 20 varieties replicated four times. Varieties planted on double-row beds with 40-inch centers. Plots 60 feet long.

Sugar analysis: From two ten-beet samples per plot by Union Sugar Division, Betteravia, California.

Remarks: Seed was furnished, test designed, and results analyzed by the United States Agricultural Research Station, Salinas, California.

VARIETY TEST, KING CITY, CALIFORNIA, 1962

(10 x 10 Latin Square) By Union Sugar Division

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
1539H1	(515HO x 569) x NB7	10,570	33.1	16.0	141
0546-22H1	85HO x 546-22	9,900	31.0	16.0	128
163TH2	(MS of NB1 x NB3) x 663 Tetra	9,860	31.8	15.6	122
163H2	US H6	9,770	30.7	15.9	144
063H1	US H2	9,700	30.6	15.9	149
0562H2	85HO x 562	9,520	30.0	15.9	143
163H2a	US H6 (New)	9,300	29.0	16.1	138
163H5	(515HO x 569) x 663	9,220	28.6	16.2	139
163H6	(515HO x 562) x 663	9,190	29.1	15.9	147
163H4	(515HO x 561-4) x 663	9,000	28.3	16.0	140
General MEAN of all varieties		9,600	30.2	15.9	Beets per 100' row
S. E. of MEAN		233	0.68	0.17	
Significant Difference (19:1)		659	1.91	N.S.	
S. E. of MEAN in % of MEAN		2.44	2.25	1.06	

Odds 19:1 = 1.993 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	9	2,113,927	23.31	0.27
Between replications	9	2,019,228	21.20	6.29
Between columns	9	344,748	4.21	1.77
Remainder (Error)	72	545,776	4.57	0.28
Total	99			
Calculated F value		3.87**	5.10**	N.S.

** Exceeds the 1% point of significance (F=2.67)

VARIETY TEST, BETTERAVIA, CALIFORNIA, 1962

Grower and location: Antone Olivera and Oso Flaco, Guadalupe, California.

Soil type: Sandy loam.

Previous crops: Beans, 1959; potatoes, 1960 and 1961.

Fertilizer used: No preplant used.
Sidedressed once with 500 lbs. per acre ammonium sulfate.

Planting date: December 28, 1961.

Thinning date: April 22, 1962.

Harvest date: September 20, 1962.

Irrigations: Three.

Diseases and insects: Not a factor in the test plot. Three replications of a 10 x 10 latin square were abandoned because of spotty stand and nematode infestation.

Experimental design: Randomized block with seven replications. Varieties planted on double-row beds with 38 inch centers. Plots 60 feet long.

Sugar analysis: From two ten-beet samples by Union Sugar Division, Betteravia, California.

Remarks: Seed was furnished, test designed, and results analyzed by United States Agricultural Research Station, Salinas, California.

The field in which the test was located yielded 25.3 tons per acre with 12.5 percent sucrose.

VARIETY TEST, BETTERAVIA, CALIFORNIA, 1962

(7 replications of each variety) By Union Sugar Division

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
163TH2	(MS of NB1 x NB3) x 663 Tetra	8,002	33.4	12.0	113
163H7	(562H0 x 546-36) x 663	7,912	33.6	11.8	147
163H2	US H6	7,812	34.8	11.2	150
063H1	US H2	7,670	33.3	11.5	160
063H3	US H5	7,447	30.8	12.1	163
163H2a	US H6 (New)	7,352	32.6	11.3	137
1539H1	(515H0 x 569) x NB7	7,292	35.3	10.3	130
163H6	(515H0 x 562) x 663	7,112	31.2	11.4	163
163H8	(562H0 x 546-8) x 663	7,098	30.2	11.8	133
163H5	(515H0 x 569) x 663	6,683	30.1	11.1	153
General MEAN of all varieties		7,438	32.5	11.5	Beets
S. E. of MEAN		301	1.23	0.22	per
Significant Difference (19:1)		N.S.	3.48	0.62	100'
S. E. of MEAN in % of MEAN		4.05	3.78	1.90	row

Odds 19:1 = 2.0 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	9	1,210,294	24.63	1.86
Between replications	6	3,149,974	56.72	0.29
Remainder (Error)	54	634,461	10.56	0.33
Total	69			
Calculated F value		N.S.	2.33*	5.58**

* Exceeds the 5% point of significance (F=2.05)
** Exceeds the 1% point of significance (F=2.75)

VARIETY TEST, WATSONVILLE, CALIFORNIA, 1962

Grower and location: Malatesta Bros., Watsonville, California.

Soil type: Heavy clay loam.

Previous crops: Sugarbeets, 1959; lettuce, 1960 and 1961.

Fertilizer used: 450 lbs. per acre 10-10-10, preplant.
600 lbs. per acre ammonium sulfate, sidedressed.

Planting date: December 29, 1961.

Thinning date: March 26, 1962.

Harvest date: September 26, 1962.

Irrigations: Two.

Diseases and insects: Infection with yellows viruses general throughout field by early June. Insect damage was not a factor in the 1962 plot. Nematode infestation was light throughout test area.

Experimental design: Randomized block with nine replications. Varieties planted on double-row beds with 42-inch centers. Plots 60 feet long.

Sugar analysis: From two ten-beet samples by Union Sugar Division, Betteravia, California.

Remarks: Seed was furnished, test designed and results analyzed by United States Agricultural Research Station, Salinas, California.

VARIETY TEST, WATSONVILLE, CALIFORNIA, 1962

(9 replications of each variety) By Union Sugar Division

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolting	Harvest Count
		Pounds	Tons	Percent	Percent	Number
163TH2	(MS of NB1 x NB3) x 663 Tetra	8,795	29.3	15.0	3.4	101
163H2a	US H6 (New)	8,417	27.4	15.4	5.5	125
163H7	(562HO x 546-36) x 663	8,360	26.9	15.5	4.6	128
1539H1	(515HO x 569) x NB7	8,295	28.1	14.7	17.7	129
163H2	US H6	7,977	26.2	15.2	5.1	124
063H3	US H5	7,830	25.8	15.2	4.3	124
163H8	(562HO x 546-8) x 663	7,708	24.9	15.4	4.1	127
163H6	(515HO x 562) x 663	7,650	25.1	15.2	6.7	129
063H1	US H2	7,557	25.0	15.1	5.3	125
163H5	(515HO x 569) x 663	7,295	23.9	15.3	5.5	129
General MEAN of all varieties		7,988	26.3	15.2	6.2	Beets
S. E. of MEAN		211	0.58	0.19	1.15	per
Significant Difference (19:1)		595	1.64	N.S.	3.26	100'
S. E. of MEAN in % of MEAN		2.64	2.21	1.25	18.55	row

Odds 19:1 = 1.994 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose	Percent Bolting
Between varieties	9	1,951,396	25.34	0.49	154.78
Between replications	8	4,244,088	17.16	2.31	20.94
Remainder (Error)	72	401,838	3.03	0.32	12.00
Total	89				
Calculated F value		4.86**	8.36**	N.S.	12.90**

** Exceeds the 1% point of significance (F=2.67)

DATA ON U.S.D.A. VARIETIES TESTED BY SPRECKELS SUGAR COMPANY, 1962

Test Areas:	S P R E C K E L S				S P R E C K E L S				SAN JUAN-HOLLISTER				KING CITY			
V a r i e t y	Tons Sug/Ac.	Beets T/Ac.	% Sugar	Beets 100'	Tons Sug/Ac.	Beets T/Ac.	% Sugar	Beets 100'	Tons Sug/Ac.	Beets T/Ac.	% Sugar	Beets 100'	Tons Sug/Ac.	Beets T/Ac.	% Sugar	Beets 100'
0539H1	2.605	18.71	13.9	133	2.947	25.76	11.5	127	4.729	31.31	15.2	154	4.787	32.89	14.6	124
0539H2	2.378	16.78	14.2	131												
USH6	2.273	16.26	14.0	129	2.427	21.30	11.4	126	4.304	27.95	15.4	162	4.632	30.94	15.0	130
163H6	2.253	16.30	13.8	138	2.102	18.61	11.4	123								
063H3	2.217	16.40	13.5	131	2.351	20.33	11.5	125								
163H4	2.063	14.87	13.9	133	2.189	18.97	11.6	126	4.458	28.40	15.8	155	4.385	29.16	15.1	129
1539H2					2.719	24.33	11.2	126								
163H5					2.237	20.70	10.8	133								
Planting Date	December 13, 1961				January 9, 1962				January 8, 1962				February 1, 1962			
Harvest Date	August 7, 1962				August 22, 1962				September 18, 1962				October 29, 1962			
General Mean	1.997	14.63	13.6	130	2.214	20.05	11.0	120	4.348	28.66	15.2	154	4.296	27.34	14.7	129
LSD @ P = .05	0.247	1.774	0.52		0.330	2.621	0.78		0.441	NS	NS		0.413	2.317	0.73	
LSD @ P = .01	0.326	2.350	0.69		0.437	3.471	1.04		NS	NS	NS		0.550	3.080	0.96	
S E of Mean	0.088	0.631	0.186		0.117	.936	0.280		0.156	1.094	0.415		0.146	0.820	0.258	
S E % of Mean	4.406	4.313	1.367		5.284	4.668	2.545		3.587	3.817	2.730		3.398	3.000	1.755	
# Var. in Test	fourteen				fourteen				ten				ten			

DATA ON U.S.D.A. VARIETIES TESTED BY SPRECKELS SUGAR COMPANY, 1962

Test Areas:	WATSONVILLE				HOLLISTER				ALISAL			
Variety	Tons Sug/Ac.	Beets T/Ac.	% Sugar	Beets 100'	Tons Sug/Ac.	Beets T/Ac.	% Sugar	Beets 100'	Tons Sug/Ac.	Beets T/Ac.	% Sugar	Beets 100'
163H5	3.875	31.55	12.3	117								
163H6	3.743	30.77	12.2	108								
0539H1	3.551	29.43	11.9	106					3.780	23.06	16.5	115
US 75	2.783	23.88	11.6	91								
1539H1					4.749	27.99	17.0	137				
USH6					4.369	25.99	16.6	120	3.481	21.23	16.4	107
USH5B									3.455	21.77	15.9	118
163H4									3.318	21.11	15.7	113
Planting Date	December 28, 1961				January 18, 1962				December 9, 1961			
Harvest Date	October 30, 1962				September 19, 1962				October 5, 1962			
General Mean	3.271	27.82	11.7	103	4.313	25.93	16.6	152	3.482	21.83	16.0	113
LSD @ P = .05	0.519	3.478	NS		0.429	2.533	0.50		0.313	1.792	NS	
LSD @ P = .01	0.691	4.624	NS		0.571	3.368	0.66		0.418	2.390	NS	
S E of Mean	0.168	1.232	0.252		0.152	0.896	0.177		0.110	0.631	0.239	
S E % of Mean	5.136	4.428	2.153		3.524	3.455	1.066		3.159	2.890	1.493	
# Var. In Test	ten				ten				eight			

VARIETY TEST, FIVE POINTS, CALIFORNIA, 1962

Grower: Herman Deavenport | By Spreckels Sugar Company

Variety	Description	Gross Sugar T/A	Beets T/A	Sucrose Percent	Beets Per 100' Row
163H5	(515HO x 569) x 663	2.620	19.15	13.73	129
163H4	(515HO x 561-4) x 663	2.478	17.20	14.60	105
163H6	(515HO x 562) x 663	2.272	16.32	13.93	106
063H2	US H6	2.030	14.55	13.93	79
0539H1	(515HO x 569) x NB7	2.013	14.25	14.17	88
063H1	US H2	1.930	14.13	13.62	74
368	US 75	1.918	14.13	13.47	98
063H3	US H5	1.875	13.83	13.60	80
1539H1	(515HO x 569) x NB7	1.733	12.30	14.17	72
LSD P = .05		0.570	3.59	NS	
LSD P = .01		0.756	4.76	NS	
General Mean		2.224	15.91	13.96	100

Design: Randomized block of 16 varieties with 6 replications.
Planted: January 15, 1962.
Machine Thinned: April 5, 1962.
Hand Thinned: April 30, 1962.
Harvested: July 30, 1962.

Poor emergence limited production on many varieties.
Diseases and bolting were not factors in the test.

Above results extracted from a test of 16 varieties.

VARIETY TEST, IMPERIAL VALLEY, CALIFORNIA, 1962

First planting - September 18, 1961

By Holly Sugar Corporation

Variety	Description	Gross sugar 1st. har. Pounds	Gross sugar 2nd. har. Pounds	Gross sugar 3rd. har. Pounds	Tons per acre 1st. har. Tons	Tons per acre 2nd. har. Tons	Tons per acre 3rd. har. Tons	Sucrose 1st. har. Percent	Sucrose 2nd. har. Percent	Sucrose 3rd. har. Percent
063H1	US H2	6,461	7,775	9,348	22.10	31.10	31.18	14.62	12.50	14.99
163H2	US H6	6,165	7,413	9,434	21.44	29.49	31.30	14.38	12.57	15.07
1539H2	569H0 x NB7	5,825	7,479	9,246	19.41	28.83	29.60	15.01	12.97	15.62
Lot 0436	US H4	5,667	7,297	8,583	19.26	27.25	26.98	14.71	13.39	15.91
Lot 9252	US 75	5,471	6,933	7,748	19.29	27.56	27.40	14.18	12.58	14.14
General MEAN of all varieties in test		5,868 1/	7,364 1/	8,796 1/	20.17	28.54	29.29	14.54	12.91	15.02
S. E. of MEAN		329 1/	217 1/	201 1/	1.11	0.47	0.61	0.17	0.24	0.14
Significant Difference (19:1)		653	413	399	3.04	1.31	1.21	0.48	0.47	0.39
S. E. of MEAN in % of MEAN		5.61	2.96	2.29	5.49	1.63	2.09	1.17	1.84	0.92

Variety	Description	Thin juice purity 1st. har. Percent	Thin juice purity 2nd. har. Percent	Thin juice purity 3rd. har. Percent	Bolting 1st. har. Percent	Bolting 2nd. har. Percent	Bolting 3rd. har. Percent	Harvest count per 100' row 1st. har. Number	Harvest count per 100' row 2nd. har. Number	Harvest count per 100' row 3rd. har. Number
063H1	US H2	90.26	90.21	92.73	1.8	9.1	10.9	213	173	225
163H2	US H6	89.32	89.79	91.98	0.5	4.0	5.3	209	170	223
1539H2	569H0 x NB7	89.65	90.27	92.06	0.4	1.5	2.5	209	168	221
Lot 0436	US H4	89.35	89.99	91.96	0.3	2.8	4.2	212	172	222
Lot 9252	US 75	88.97	89.37	90.74	0.4	1.8	2.8	210	176	225
General MEAN of all varieties in test		89.22	90.08	91.63					178	223
S. E. of MEAN			0.40	0.48						
Significant Difference (19:1)			1.13	0.95						
S. E. of MEAN in % of MEAN			0.45	1.04						

Harvest dates: April 20, 1962; May 15, 1962; June 18, 1962.

1/ By short cut formula.

Cooperator: Nelson Correll.

Design: 4 x 4 Triple lattice with 9 replications. Randomized block analysis.

Plot size: Two-rows spaced 34 inches apart and 53 feet long.
Two-rows x 50' harvested.

Results extracted from tests of 16 varieties.

Agricultural Research Department
Holly Sugar Corporation

VARIETY TEST, IMPERIAL VALLEY, CALIFORNIA, 1962

Second planting - October 10, 1961

By Holly Sugar Corporation

Variety	Description	Gross sugar 2nd. har.	Gross sugar 3rd. har.	Gross sugar 4th. har.	Tons per acre 2nd. har.	Tons per acre 3rd. har.	Tons per acre 4th. har.	Sucrose 2nd. har.	Sucrose 3rd. har.	Sucrose 4th. har.
		Pounds	Pounds	Pounds	Tons	Tons	Tons	Percent	Percent	Percent
1539H2	569HO x NB7	5,718	8,741	7,740	25.32	29.43	28.56	11.29	14.85	13.55
063H1	US H2	5,508	8,205	7,549	24.95	29.93	29.10	11.04	13.71	12.97
163H2	US H6	5,393	8,292	7,894	25.15	29.64	30.43	10.72	13.99	12.97
Lot 0436	US H4	5,094	7,580	6,926	22.03	25.54	25.22	11.56	14.84	13.73
Lot 9252	US 75	4,646	6,654	5,621	21.16	24.70	23.08	10.98	13.47	12.18
General MEAN of all varieties in test		5,168	7,672	6,973	23.15	27.26	26.68	11.17	14.07	13.06
S. E. of MEAN		93 1/	160	201	0.19	0.45	0.65	0.18	0.18	0.20
Significant Difference (19:1)		185	317	563	0.54	1.26	1.83	0.50	0.50	0.56
S. E. of MEAN in % of MEAN		1.80	2.09	2.88	0.83	1.65	2.44	1.60	1.27	1.53

Variety	Description	Thin juice purity 2nd. har.	Thin juice purity 3rd. har.	Thin juice purity 4th. har.	Bolting 2nd. har.	Bolting 3rd. har.	Bolting 4th. har.	Harvest count per 100' row 2nd. har.	Harvest count per 100' row 3rd. har.	Harvest count per 100' row 4th. har.
		Percent	Percent	Percent	Percent	Percent	Percent	Number	Number	Number
1539H2	569HO x NB7	87.50	91.51	90.18	0.1	0.1	0.1	156	224	180
063H1	US H2	88.04	90.10	89.22	0.4	0.4	0.7	154	218	191
163H2	US H6	86.72	90.49	88.23	---	0.2	0.4	148	219	187
Lot 0436	US H4	86.69	90.99	89.75	---	0.2	0.2	143	222	197
Lot 9252	US 75	85.69	89.10	87.69	0.2	0.2	0.1	153	220	184
General MEAN of all varieties in test		86.80	90.44	89.02				154	220	190
S. E. of MEAN			0.38	0.41						
Significant Difference (19:1)			1.07	1.17						
S. E. of MEAN in % of MEAN			4.23	4.61						

Harvest dates: May 15, 1962; June 19, 1962; July 25, 1962.

1/ By short cut formula.

Cooperator: Nelson Correll.

Design: 4 x 4 Triple lattice with 9 replications. Randomized block analysis.

Plot size: Two-rows spaced 34 inches apart and 53 feet long.
Two-rows x 50' harvested.

Results extracted from tests of 16 varieties.

Agricultural Research Department
Holly Sugar Corporation

Effect of Environment on Bolting Resistance

The severity of the bolting problem in California varies greatly from one year to another. Much of this variation is associated with differences in temperature. In 1962 both winter and summer temperatures were below normal, particularly in the coastal districts, and bolting percentages were high.

Bolting information was obtained from tests planted at Salinas on November 13, 1961, and at Tracy on September 26, 1961. In the Salinas test the varieties and hybrids were replicated 4 times and the inbreds twice. The Tracy test was planted by Dr. D. D. Dickenson of the Holly Sugar Corporation, and the entries were replicated 4 times.

Not only were winter temperatures below normal at Salinas but cool, foggy conditions persisted during the entire summer and new bolters continued to appear until harvest. Bolting counts were made at 3 dates and bolting percentages are shown in Tables 1 and 2. Varieties differed in bolting resistance at the different dates of counting. The monogerm hybrid (515 x 569) x NB7 (1539H1) bolted 0.8, 33, and 52 percent at progressive monthly intervals, whereas US H2 bolted 6, 21, and 37 percent on the same dates. Bolting apparently starts slower in the monogerm hybrid but proceeds at a rapid rate when temperatures remain low during the spring and summer. In 1961, 1539H1 bolted only 11 percent in the November planting at Salinas and was similar to US H6 in resistance (Table 3). At Tracy, 1539H1 and US H6 showed similar bolting resistance in 1961 and 1962.

NB1 and MS of NB1 bolted 79 and 69 percent, respectively, in the 1962 Salinas test, whereas in the Tracy test these lines bolted only 27 and 28 percent. The extremely bolting-resistant NB6 inbred bolted 6 percent at Salinas and was the most bolting ever observed in California tests with this inbred. No bolting was observed in NB6 at Tracy, but almost complete bolting occurred at both Medford and Salem, Oregon. One hundred percent bolting occurred in 8503 at Salinas, but incomplete bolting occurred in an August planting of this inbred at Salem. F61-515 bolted 83 percent at Salinas and only 25 percent at Tracy. This inbred often gives bolting difficulties in Oregon seed fields. The new 563 monogerm inbred bolted 13 percent in the Salinas test, indicating that it has good bolting resistance when grown in the coastal areas.

At Salinas the F_1 hybrid 562 x 569 bolted 32 percent, whereas the reciprocal 569 x 562 bolted 62 percent. In the Tracy test the reverse relationship existed, with 562 x 569 bolting 63 percent and 569 x 562 only 43 percent.

Numerous unexplained irregularities in bolting behavior continue to occur in tests at Salinas, Tracy, and in Oregon. Variations are especially marked in inbred lines and in F_1 hybrids between inbreds. European breeders report a marked difference in the bolting resistance of different seed increases of the same variety depending on the environment in which the seed is produced. There is still much to be learned about the factors responsible for the induction of bolting. A better understanding of these factors would aid in the development of extremely bolting-resistant varieties which could be reproduced in the seed-growing areas.

Table 1. Percent bolting in sugarbeet selections and hybrids planted at Salinas, California, on November 13, 1961.

Variety	Description	Date of Counting 6-7-62 Percent	7-11-62 Percent	8-14-62 Percent
368	US 75	2	10	18
663	NB. CT sel. (US15 x US22/3)	2	6	15
164	Bolt. res. sel. 663	0	4	8
165	Bolt. res. sel. 663	0.3	4	8
163T	Tetraploid 663	2	11	20
063H1	US H2	6	21	37
163TH2	(MS of NB1 x NB3) x 663 Tetra	2	7	18
163H2	US H6	2	13	27
163H2a	US H6 (New)	1	14	23
063H3	US H5	4	12	26
163H4	(515HO x 561) x 663	4	21	34
163TH1	(515HO x 569) x 663 Tetra	3	15	30
163H5	(515HO x 569) x 663	5	29	47
163H6	(515HO x 562) x 663	2	17	34
163H7	(562HO x 546-36) x 663	2	14	27
163H8	(562HO x 546-8) x 663	2	7	18
087H1	(MS of NB1 x NB5) x F58-87	1	5	13
1539H1	(515HO x 569) x NB7	0.8	33	52
1539H2	569HO x NB7	3	17	36
F60-547H1	MS of NB1 x NB5	2	17	29
1547H1	MS of NB1 x NB5	0.2	8	17
F60-554H1	MS of NB1 x NB4	0.5	9	18
F60-512H1	MS of NB5 x NB6	0	5	11
F61-562H1	515HO x 562	17	56	69
F61-562H2	569HO x 562	9	40	62
F61-569H1	515HO x 569	12	49	72
F61-569H2	561HO x 569	4	26	38
F61-569H3	562HO x 569.	1	14	32
F61-561H1	569HO x 561	3	22	40
0546-8H2	85HO x 546-8	0.6	4	14
0546-22H1	85HO x 546-22	2	13	23
0546-36H2	85HO x 546-36	0.2	5	10
	L. S. D. at 5% point	--	6.2	8.1

Table 2. Percent bolting in sugarbeet inbreds planted at Salinas, California, on November 13, 1961.

Variety	Description	Date of Counting 6-7-62	7-11-62	8-14-62
		Percent	Percent	Percent
5502	NB1	28	68	79
F59-502HO	MS of NB1	10	50	69
F58-554	NB4	0	2	9
1547	NB5	0	4	10
F60-547	NB5	0.7	11	17
F60-547HO	MS of NB5	0	7	17
F60-512	NB6	0	1	6
1539	NB7	2	26	40
F61-562	Monogerm inbred	7	28	39
F61-562HO	MS of 562	7	25	44
F61-569	Monogerm inbred	0.7	25	35
F61-569HO	MS of 569	3	29	48
F61-515S	Inc. 515	2	60	83
F61-515HOM	515HO x 515	2	56	77
F61-515HOS	515HO x 515	2	64	82
8503	Mild. res. inbred	40	89	100
0546-8	Monogerm inbred	0.7	16	25
0546-8H1	562HO x 546-8	0	4	19
0546-22	Monogerm inbred	6	34	49
1546-22C2	CT res. sel. 0546-22	1	15	19
0546-36	Monogerm inbred	0.7	6	16
0546-36H1	562HO x 546-36	0	9	23
0546-48	Monogerm inbred	5	21	40
1561-16C2	Monogerm inbred	0.7	15	24
1563	Monogerm inbred	4	8	13

Table 3.--Percent bolting in sugarbeet varieties and inbreds at Salinas and Tracy, California, in 1961 and 1962.

Varieties and Hybrids	Salinas 9/9/60 Planting	Salinas 11/4/60 Planting	Salinas 11/13/61 Planting	Tracy[1] 9/23/60 Planting	Tracy[1] 9/26/61 Planting
	Percent	Percent	Percent	Percent	Percent
US 75	52	5	18	39	55
663	--	--	15	--	80
(1 x 3) x 663	47	15	37	67	77
(1 x 4) x 663	--	13	26	60	49
(1 x 5) x 663	28	10	23	56	58
(5 x 6) x 787	29	5	13	26	39
(515 x 569) x NB7	39	11	52	55	59
(515 x 569) x 663	--	19	47	57	77
(515 x 562) x 663	--	--	69	--	60
(515 x 561) x 663	--	23	34	62	61
(562 x 546-8) x 663	--	--	18	--	59
(562 x 546-36) x 663	--	--	27	--	70
NB1 x NB4	--	3	18	52	60
NB1 x NB5	--	5	29	--	34
NB5 x NB6	12	2	11	10	12
515 x 569	22	23	72	63	58
515 x 562	--	--	69	--	66
561 x 569	--	--	38	--	68
562 x 569	--	--	32	--	63
569 x 562	--	--	62	--	43
L. S. D. at 5% point	--	5.2	7.9	17.2	18.3
Inbreds					
NB1	3	46	79	20	27
MS of NB1	2	15	69	30	28
NB5	--	2	10	--	27
NB6	0	0	6	0	0
NB7	14	2	40	30	21
515	13	48	83	9	25
562	0	10	39	14	30
569HO	13	--	48	31	38
L. S. D. at 5% point	--	11.0	--	17.2	18.3

[1] Tracy test by Dr. D. D. Dickenson, Holly Sugar Corporation.

PERFORMANCE OF TRIPLOIDS

The performances of diploid and triploid hybrids have been compared in tests at the U. S. Agricultural Research Station, Salinas, California, since 1956. Triploids used in these tests included hybrids between diploid male steriles from Salinas and high performing European tetraploids. To produce these hybrids cooperative arrangements were entered into between the U. S. Agricultural Research Station and Bush Johnsons Limited in England and also the Sugar Beet Breeding Institute in Sweden. Four male steriles were furnished to the European cooperators and they supplied several tetraploid parents. Triploid hybrids were produced in England, Sweden, and California.

The results of evaluation tests with these triploids were reported in Sugar Beet Research, 1960 and 1961 Reports. As expected, performance of the triploids varied greatly but, in general, the yield and sucrose percentage of the best triploids were similar to those of the best diploids. In none of the 1961 and 1962 tests did a triploid perform significantly better than did the best diploid.

1962 Brawley Test

A group of 21 triploids and 7 diploids were included in an evaluation test at the Southwestern Irrigation Field Station, Brawley, California. The test was planted by K. D. Beatty on September 28, 1961, and harvested April 24 - 25, 1962. The varieties were in single-row plots 40 feet long and were replicated 10 times. Good stands were obtained in nearly all varieties and little damage was caused by diseases or insects.

The triploids included 16 hybrids between US male steriles and Hilleshög tetraploids, 3 hybrids between US male steriles and Bush Johnson tetraploids, and 2 hybrids involving crosses between diploid male steriles and tetraploid 663 produced by Dr. Hammond.

Root yields ranged from a high of 27.2 tons per acre for the triploid (1 x 3) x 663(4n) to a low of 18.3 tons per acre for a monogerm triploid with a Hilleshög tetraploid. Triploids with the Bush Johnson tetraploids yielded well but tended to be low in sucrose percentage. Triploids with the Hilleshög tetraploids were lower in root yield but of better quality. None of the triploids were superior to the better diploid hybrids. US H2, US H6, and the monogerm 1539H1 were among 10 hybrids which gave the highest gross sugar yield.

1962 Salinas Test

A group of 31 triploids and 5 diploid hybrids were evaluated in duplicate 6 x 6 triple-lattice tests planted at Salinas on December 14, 1961, and harvested October 1 - 3, 1962. The varieties were in 2-row plots, 45 feet long. Good stands were obtained in all varieties. No damage was caused by either curly top or downy mildew, but yellows infection was prevalent throughout the test. Temperatures were below normal, causing severe bolting in some of the triploid hybrids.

The triploids included 26 hybrids between US male steriles and Hilleshög tetraploids, 3 hybrids between US male steriles and Bush Johnson tetraploids, and 2 hybrids involving crosses between diploid male steriles and tetraploid 663.

Root yields of the triploids ranged from 30.4 to 38.4 tons per acre. Bolting probably reduced the yield of a few of the triploids. Three of the 5 diploids in the test ranked among the top 11 varieties with a similar statistical performance. The 1539H1 diploid monogerm hybrid was outstanding both from the standpoint of tonnage and sucrose percentage. Triploids with the Bush Johnson tetraploids yielded very well but had a tendency to low sugar. Performance of triploids with Hilleshög tetraploids varied greatly both in root yield and sucrose percentage. Top vigor of most triploids was very good and was superior to that of the diploid hybrids.

1962 King City Test

A group of 16 triploids and 4 diploid hybrids were tested at King City, California, in a randomized block arrangement with 4 replications. The planting was made March 5, 1962 and harvested October 15 - 17, 1962. Moderate curly top infection occurred and caused some damage to triploids with susceptible European tetraploids. Root yields of the triploids ranged from 19.8 to 30.4 tons per acre. Differences in sucrose percentage were not significant. Two of the 3 hybrids showing the highest statistical ranking for gross sugar yield were diploid. The monogerm 1539H1 again performed well.

Results With Diploid and Triploid US H2

Comparisons were made between (1 x 3) x 663(2n) and (1 x 3) x 663(4n) in 8 variety trials in the Imperial Valley, the Salinas Valley, and the Santa Maria Valley. The tetraploid parent was produced by Dr. B. L. Hammond from 9 plants identified as tetraploid chimeras following colchicine treatment and then rechecked in the C_1 generation.

The gross sugar yield of the triploid averaged 6.7 percent higher than did that of the diploid hybrid. The sucrose percentage of the triploid averaged 0.3 percentage points lower than did that of the diploid.

In a bolting test planted November 13, 1961, at Salinas, the triploid bolted 18.1 percent compared to 37.2 percent for the diploid. In a field curly-top evaluation test at Thatcher, Utah, Mr. A. M. Murphy counted 75 percent curly top infected plants in the triploid compared with 60 percent in the diploid. The curly top grade for the triploid was 5 compared with a grade of 4 for the diploid (0 = no curly top: 10 = dead plants).

The results obtained in the 1962 tests may not give an entirely accurate comparison of diploid and triploid forms of US H2, because the tetraploid parent arose from only 9 plants. This relatively small number of plants may not necessarily be representative of 663.

TRIPLOID EVALUATION TEST,[1] BRAWLEY, CALIFORNIA, 1962

(28 varieties replicated 10 times)

Planted: September 28, 1961
Harvested: April 24-25, 1962

Variety No.	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
163TH2	(MS of NB1 x NB3) x 663T	8,190	27.2	15.1	130
1954-1H2	(MS of NB1 x NB5) x D10/59	8,180	25.8	15.9	132
063H1	US H2 (2n)	8,130	25.7	15.9	144
1954-4H2	(MS of NB1 x NB5) x D38/59	8,050	27.1	14.9	135
163H2	US H6 (2n)	8,010	26.0	15.5	142
1539H1	(515HO x 569) x NB7 (2n)	7,990	24.4	16.4	144
1954-6H2	(MS of NB1 x NB5) x E10/59	7,970	25.8	15.5	127
1958H2	(MS of NB1 x NB5) x H6370	7,910	24.0	16.5	136
1960H2	(MS of NB1 x NB5) x H6351	7,820	23.8	16.5	130
1962H2	(MS of NB1 x NB5) x H5338	7,760	24.1	16.2	134
1964H2	(MS of NB1 x NB5) x H7366	7,710	23.8	16.2	144
163TH1	(515HO x 569) x 663 Tetra	7,660	24.4	15.8	120
1963H2	(MS of NB1 x NB5) x H5261	7,460	23.0	16.3	141
1539H3	561HO x NB7 (2n)	7,400	23.1	16.1	140
1539H2	569HO x NB7 (2n)	7,400	22.5	16.6	143
1955H2	(MS of NB1 x NB5) x H3608	7,360	22.9	16.2	135
184H3	(MS of NB1 x NB3) x 984 (2n)	7,350	22.5	16.4	136
1962H1	(515HO x 569) x H5338	7,300	21.1	15.8	128
1961H2	(MS of NB1 x NB5) x H6354	7,260	22.9	15.9	131
1960H1	(515HO x 569) x H6351	7,210	22.3	16.2	132
1963H1	(515HO x 569) x H5261	7,170	22.9	15.7	129
1956H2	(MS of NB1 x NB5) x H18	7,040	21.9	16.1	135
1958H1	(515HO x 569) x H6370	6,880	21.2	16.3	134
1961H1	(515HO x 569) x H6354	6,810	20.9	16.4	122
1964H1	(515HO x 569) x H7366	6,730	20.8	16.3	123
368	US 75 (2n)	6,470	20.2	16.1	138
1956H1	(515HO x 569) x H18	6,310	19.4	16.4	124
1955H1	(515HO x 569) x H3608	5,990	18.3	16.4	123

1/ Varieties triploid, except for 7 diploids indicated by (2n).

General MEAN of all varieties	7,410	23.2	16.0	Beets per 100' row
S. E. of MEAN	165	0.68	0.29	
Significant Difference (19:1)	460	1.89	0.81	
S. E. of MEAN in % of MEAN	2.23	2.92	1.80	

Odds 19:1 = 1.97 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	27	3,459,307	48.59	1.79
Between replications	9	304,843	31.62	15.49
Remainder (Error)	243	271,738	4.62	0.84
Total	279			
Calculated F value		12.73**	10.52**	2.13**

** Exceeds the 1% point of significance (F=1.84)

TRIPLOID EVALUATION TEST[1], SALINAS, CALIFORNIA, 1962

Planted: December 14, 1961
Harvested: October 1-3, 1962

(6 replications of each variety)

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Bolting Percent	Harvest Count Number
1539H1	(515H0 x 569) x NB7 (2n)	10,780	37.1	14.5	12.5	146
1954-6H2	(MS of NB1 x NB5) x E10/59	10,690	37.9	14.1	5.1	131
163TH1	(515H0 x 569) x 663 Tetra	10,610	38.4	13.8	4.7	146
163TH2	(MS of NB1 x NB3) x 663T	10,340	36.7	14.1	2.2	136
163H2	(MS of NB1 x NB5) x 663 (2n)	10,280	36.0	14.3	6.6	147
1954-1H2	(MS of NB1 x NB5) x D10/59	10,090	35.9	14.0	2.2	146
1954-4H2	(MS of NB1 x NB5) x D38/59	10,000	36.3	13.8	8.0	142
1963H1	(515H0 x 569) x H5261	9,920	33.6	14.7	7.9	143
1962H2	(MS of NB1 x NB5) x H5338	9,870	33.3	14.8	8.9	142
1962H1	(515H0 x 569) x H5338	9,850	34.3	14.3	12.0	139
1539H2	569H0 x NB7 (2n)	9,840	35.4	13.9	6.5	148
1958H2	(MS of NB1 x NB5) x H6370	9,780	34.5	14.1	11.5	147
1963H2	(MS of NB1 x NB5) x H5261	9,380	33.5	14.0	2.5	139
1960H1	(515H0 x 569) x H6351	9,340	32.7	14.2	16.8	138
1955H2	(MS of NB1 x NB5) x H3608	9,290	31.5	14.7	7.3	149
1956H1	(515H0 x 569) x H18	9,250	31.5	14.7	9.4	148
1956H2	(MS of NB1 x NB5) x H18	9,090	31.3	14.5	8.0	136
1964H2	(MS of NB1 x NB5) x H7366	9,080	31.5	14.4	9.2	140
1961H1	(515H0 x 569) x H6354	9,030	31.6	14.3	16.3	141
1960H2	(MS of NB1 x NB5) x H6351	9,020	31.6	14.3	8.3	142
1970H3	(MS of NB1 x NB4) x H9395	8,980	32.2	14.0	29.7	141
063H1	(MS of NB1 x NB3) x 663 (2n)	8,950	33.2	13.4	5.0	140
1958H1	(515H0 x 569) x H6370	8,930	32.2	13.9	15.0	139
1967H1	MS of NB1 x H9354	8,800	31.5	13.9	54.1	137
1961H2	(MS of NB1 x NB5) x H6354	8,710	30.4	14.3	17.0	133
1964H1	(515H0 x 569) x H7366	8,710	31.4	13.9	17.1	141
1955H1	(515H0 x 569) x H3608	8,650	30.1	14.4	12.8	138
1969H1	(MS of NB1 x NB4) x H9376	8,560	32.9	13.1	25.2	143
1968H1	MS of NB1 x H9367	8,480	30.4	14.0	45.8	139
1968H3	(MS of NB1 x NB4) x H9369	8,470	30.1	14.1	36.7	147
1970H2	(MS of NB1 x NB3) x H9394	8,290	30.0	13.8	36.8	142
1970H1	MS of NB1 x H9393	8,250	29.8	13.8	55.3	133
1968H2	(MS of NB1 x NB3) x H9368	8,100	28.9	14.0	63.2	143
1967H3	(MS of NB1 x NB4) x H9356	8,020	30.1	13.3	36.1	142
1967H2	(MS of NB1 x NB3) x H9355	7,980	30.4	13.1	45.5	133
063H3	(MS of NB1 x NB4) x 663 (2n)	7,840	29.1	13.5	4.6	153
General MEAN of all varieties		9,200	32.7	14.1	18.48	Beets
S. E. of MEAN		357	1.09	0.25	2.21	per
Significant Difference (19:1)		997	3.03	0.69	6.16	100'
S. E. of MEAN in % of MEAN		3.89	9.27	1.78	11.96	row

1/- Except for 5 diploids indicated by (2n)

Odds 19:1 = 1.97 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose	Percent Bolting
Between varieties	35	3,963,674	40.29	1.07	1725.93
Between replications	5	9,773,773	60.52	5.10	149.73
Remainder (Error)	175	766,833	7.10	0.37	29.35
Total	215				
Calculated F value		5.17**	5.67**	2.92**	58.81**

** Exceeds the 1% point of significance (F=1.76)

TRIPLOID EVALUATION TEST,[1] KING CITY, CALIFORNIA, 1962

(4 replications of each variety) By Union Sugar Division

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
1539H1	(515H0 x 569) x NB7 (2n)	11,150	34.0	16.4	140
1970H2	(MS of NB1 x NB3) x H9394	10,510	30.4	17.3	159
063H3	(MS of NB1 x NB4) x 663 (2n)	10,410	32.0	16.3	143
063H1	(MS of NB1 x NB3) x 663 (2n)	10,270	31.5	16.3	156
163H2	(MS of NB1 x NB5) x 663 (2n)	10,070	31.1	16.2	152
1964H2	(MS of NB1 x NB5) x H7366	9,670	28.5	17.0	145
1958H2	(MS of NB1 x NB5) x H6370	9,370	29.0	16.2	145
1968H2	(MS of NB1 x NB3) x H9368	9,270	27.7	16.9	144
1954-1H2	(MS of NB1 x NB5) x D10/59	9,210	28.5	16.3	137
1960H2	(MS of NB1 x NB5) x H6351	8,880	26.3	16.9	138
1954-4H2	(MS of NB1 x NB5) x D38/59	8,830	28.0	15.9	140
1956H2	(MS of NB1 x NB5) x H18	8,750	26.0	16.8	150
1963H2	(MS of NB1 x NB5) x H5261	8,550	23.6	16.7	135
1962H2	(MS of NB1 x NB5) x H5338	8,490	25.2	17.0	129
1955H2	(MS of NB1 x NB5) x H3608	8,300	25.4	16.4	139
1954-6H2	(MS of NB1 x NB5) x E10/59	8,170	26.3	15.6	124
1967H2	(MS of NB1 x NB3) x H9355	8,120	24.5	16.7	140
1963H1	(515H0 x 569) x H5261	7,850	24.2	16.3	133
1961H1	(515H0 x 569) x H6354	7,490	23.2	16.2	129
1956H1	(515H0 x 569) x H18	6,630	19.8	16.8	124
General MEAN of all varieties		9,000	27.4	16.5	Beets per 100' row
S. E. of MEAN		257	0.93	0.24	
Significant Difference (19:1)		727	2.64	N.S.	
S. E. of MEAN in % of MEAN		2.86	3.40	1.47	

[1] Except for 4 diploids indicated by (2n)

Odds 19:1 = 2 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	19	5,068,572	46.35	0.70
Between replications	3	16,638,235	185.82	2.55
Remainder (Error)	57	659,687	8.67	0.59
Total	79			
Calculated F value		7.68**	5.35**	N.S.

** Exceeds the 1% point of significance (F=2.23)

TRIPLOID VARIETY TEST,[1/] IMPERIAL VALLEY, CALIFORNIA, 1962

Intermediate planting - October 14, 1961 | By Holly Sugar Corporation

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Thin Juice Purity Percent	Bolting Percent	Harvest Count Number
1960H2	(MS of NB1 x NB5) x H6351	8,182	29.82	13.72	87.74	0.3	209
1954-6H2	(MS of NB1 x NB5) x E10/59	8,033	32.16	12.49	86.87	1.0	211
163TH2	(MS of NB1 x NB3) x 663 Tetra	7,970	32.11	12.41	87.40	0	195
1539H3	561HO x NB7 (2n)	7,943	30.55	13.00	87.27	0	218
1962H2	(MS of NB1 x NB5) x H5338	7,913	29.46	13.43	87.24	0.4	214
1539H2	569HO x NB7 (2n)	7,869	28.66	13.73	87.92	0.1	217
163H6	(515HO x 562) x 663 (2n)	7,562	28.20	13.41	88.04	0.3	215
1961H2	(MS of NB1 x NB5) x H6354	7,507	27.52	13.64	87.88	1.7	204
1964H2	(MS of NB1 x NB5) x H7366	7,505	29.34	12.70	87.82	0.6	215
Lot 0436	US H4 (2n)	7,246	26.20	13.83	89.31	0.2	220
1963H2	(MS of NB1 x NB5) x H5261	7,178	27.82	12.90	87.22	0.2	217
063H1	US H2 (2n)	7,174	28.31	12.67	87.76	0.4	215
1955H2	(MS of NB1 x NB5) x H3608	6,912	26.91	12.84	86.12	0.6	213
1956H2	(MS of NB1 x NB5) x H18	6,872	26.07	13.18	88.27	0	207
Lot 9252	US 75	6,328	23.82	13.28	87.14	0.2	215

1/ Except for US 75 and 5 hybrids indicated by (2n)

Harvest date: June 20, 1962.
Cooperator: Nelson Correll.
Design: 6 x 6 Triple lattice with 9 replications.
Plot size: Two-rows spaced 34 inches apart and 53 feet long.
Two-rows x 50' harvested.
Results extracted from a test of 36 varieties.

Note: The data for this table arrived just before the Project 24 report was mailed to Beltsville. The information in this table has not been used in preparing the section entitled "Performance of Triploids". -- J. S. McFarlane

DEVELOPMENT OF TRIPLOID AND TETRAPLOID SUGARBEETS

B. L. Hammond

In last year's report it was stated that seed increases of the tetraploid form of the multigerm top-cross parent, 663, were being made. As pollen parent, this tetraploid, along with the male-sterile monogerm diploid, MS of 7515 X 7569, and the male-sterile multigerm diploid, MS of NB1 X NB3, were isolated for the production of triploid seed. These triploid hybrids were evaluated in 1962 in USDA and cooperative sugar company variety tests. The results of these tests will be found in the section of this report dealing with the performance of triploids.

A composite seed increase was made in 1962 of a number of T8-line single-plant tetraploid selections. The T8 line was a group of tetraploid plants produced from S_6(US22/3 X NB1).

Seed of 46 selected colchicine-treated plants of the multigerm inbred 0539 (NB7) was harvested in April 1961 and some immediately planted, from which 125 seedlings were obtained. Ninety-six percent of the plants were tetraploids. These were placed under thermal induction in August 1961 together with a group of plants of the self-sterile tetraploid of 663 origin and removed in January 1962. These two tetraploids derived from high-yielding diploids were crossed in February 1962 to produce tetraploid pollinators. The seed was harvested in June, a portion of which was planted in Oregon in August to obtain stecklings for seed increase at Salinas in 1963. C_1 generation seed of 0539C_0 was also planted in Oregon in August 1961 to obtain stecklings for a seed increase at Salinas. Of the 35 stecklings brought from Oregon, 33 were tetraploid. These were placed in an isolator in March 1962. Seed was harvested in August.

The type O monogerm inbred, 0562, and its male-sterile equivalent, 9561H2, were chosen in the early part of this program for the development of a male-sterile monogerm tetraploid line. Germinating seed was colchicine-treated in September 1960. In December 1960, 50 plants of the former and 66 of the latter were selected as being highly tetraploid chimeras on the basis of chromosome observations in vegetative tissue and exposed to thermal induction for 120 days. At the end of this period, 33 plants of the former and 47 of the latter had survived. Just prior to flowering, young tissue from the tip of the floral axis of each was examined cytologically. Twenty-four of the former and 42 of the latter were selected for pollination on the basis of the apparent absence of diploid cells. Seed from these lines was planted in September 1961. From the cross between colchicine-treated 0562 and its male-sterile equivalent, 9561H2, 121 seedlings, all tetraploid, were obtained. From 0562 selfed, 63 plants were obtained, all also tetraploid. These were placed in the coldroom in March 1962 and removed in early August when 35 plants of each line were placed in

an isolator to interpollinate for seed increases. These plants were harvested in late November for drying and seed threshing. No pollen was observed on the tetraploid plants of 9561H2 X 0562, indicating an excellent retention of male-sterility.

A procedure similar to that above was used in connection with the diploid monogerm lines SL0156 (MSmm X CT5mm) and SL0267 (SLC129 mmaa X CT5mmAa), both developed by Dr. Owen. Colchicine treatment was begun in November 1960. C_1 seed from the C_0 generations was harvested in December 1961 and planted in February 1962. One-hundred twenty-five tetraploid plants of 0267 selfed and 100 tetraploid plants of 0156 X 0267 were placed under thermal induction in July 1962. These will be removed soon for seed increases.

Seventy-four colchicine-treated plants of the monogerm inbred 0546-36 were selected in July 1961 on the basis of cytological examination and thermally induced for 4 months, after which they were interpollinated. C_1 seed was harvested in April 1962. A portion of the seed was planted, from which were obtained 74 tetraploid seedlings with green hypocotyls and 60 with red hypocotyls. These plants are now under thermal induction and a seed increase will be made from each class.

Germinating seed of the monogerm inbred 0546-48 was colchicine-treated in June 1961. After cytological examinations, 72 were selected for thermal induction in October 1961. These were removed in March 1961 and interpollinated. Thirty-two grams of C_1 seed was harvested in July 1962. Some of this was planted in October for selection of tetraploid plants for seed increase.

Fifty-seven colchicine-treated plants of the monogerm inbred 0546-22 planted in July 1961 were selected and placed in the coldroom in November 1961. These were removed in April 1962 and interpollinated. Only 4 1/2 grams of C_1 seed was obtained.

One-hundred thirty-eight colchicine-treated seedlings of the monogerm inbred 1546-22 were transplanted to pots in October 1961. Forty-nine of these were selected for thermal induction in December 1961, and removed in May 1962 for interpollination. Only 17 grams of C_1 seed was obtained, indicating a fairly high degree of infertility. Some of this seed was planted in October 1962 for the selection of tetraploids for seed increase. Selection 1546-22 differs from 0546-22 in being more highly resistant to curly top.

Tetraploids are also being produced from the type O monogerm inbred 1672. This selection originated from a backcross to the NB1 multigerm inbred. Colchicine-treated seed was planted in September 1961. The seedlings were transplanted in pots in October 1961. Fifty-four plants including 15 with green hypocotyls were selected for thermal induction in February 1962. These were removed from the coldroom in July 1962 and interpollinated. The C_1 seed was harvested in November 1962. Only

1.8 grams of seed was obtained from the plants with green hypocotyls, 14.5 grams was obtained from plants with red hypocotyls. Seed increases will be made from both classes of C_1 tetraploid plants.

Germinating seed of the type O monogerm 1561-16-7C1 were treated with colchicine in January 1962. The seedlings were potted in March and, on the basis of cytological observations, 42 plants were placed under thermal induction in May 1962. These were removed in October and are now being interpollinated. This inbred was recently found highly resistant to curly top.

Sixty-six colchicine-treated seedlings of the type O multigerm 871 were selected for thermal induction in July 1961. These were removed from the coldroom in November 1961 and interpollinated after being examined cytologically. Fourteen of these having green hypocotyls were pollinated separately. C_1 seed was obtained from each class in June 1962. In August, seed from both classes was planted in Oregon to obtain stecklings for seed increase at Salinas. In August, 871 C_1 seed was also planted in the Salinas greenhouse to obtain tetraploid seedlings for crossing with 0539T (tetraploid of 0539 already produced) planted at the same time. Of the 150 871-C_1-seedlings potted, all were tetraploid. These, together with 125 tetraploid seedlings of 0539, are now under thermal induction.

Germinating seed of the type O multigerm F57-85 and its male-sterile equivalent, F57-85HO, was colchicine-treated in late fall of 1961. One-hundred-five seedlings of each line were potted in January 1962. Cytological examination of young leaves indicated an apparent absence of diploid cells in 65 plants of 57-85 and in 67 plants of F57-85HO. These were placed under thermal induction in April 1962 and removed in September. Crosses between F57-85HO C_o as well as F57-85 C_o sib crosses have been made.

It is interesting to note here that, among the above obtained seedlings, 9 plants of F57-85 and 5 plants of F57-85HO bolted prior to thermal induction. As far as it can be ascertained, bolting in the greenhouse of commercial varieties not thermally induced apparently has not been observed; and F57-85 is considered a highly non-bolting commercial variety. No explanation for this behavior is offered. However, bolting may have been due to a response of these plants to the colchicine treatment or to a combination of the treatment and certain environmental factors. These plants were crossed in the manner described above for the non-bolting ones. The small amount of harvested C_1 seed was planted in August 1962. From the cross, F57-85HOC_o X F57-85C_o, 40 seedlings were obtained, all of which are tetraploid. Twenty-three seedlings were obtained from F57-85C_o, all of which are tetraploid. Seed increases will be used for later comparison with tetraploids from non-bolting plants with respect to degree of bolting under field conditions.

Germinating seed of the monogerm inbred F61-515 was colchicine-treated in June 1962. Of the 52 plants obtained, 31 were selected on the basis of cytological examination for thermal induction in October. This selection was highly sensitive to the colchicine treatments. Since nearly 100 percent of these plants have red hypocotyls, this inbred should be of considerable value in outcrossing studies.

Forty-eight colchicine-treated plants of the vigorous multigerm inbred 1547 (NB5) planted in July 1962 were selected and placed in the coldroom in October. Twenty-eight of these have green hypocotyls, and 20 red hypocotyls. The latter will be used in outcross studies. Another planting of this selection has been made for the purpose of securing additional plants with red hypocotyls.

In July 1962, germinating seed of 586 was colchicine-treated. This selection is an open-pollinated multigerm. On the basis of cytological observations, 62 plants were selected for thermal induction and will be placed in the coldroom in December. Twenty plants have green hypocotyls and 42 red hypocotyls. This selection is high in sucrose percentage but low in root yield. Crosses will be made with 663T in an attempt to develop a tetraploid top-cross parent with good tonnage and sucrose percentage.

Colchicine-treated seedlings of the multigerm inbred F59-509 (NB3) planted in August 1962 were transplanted to pots in November. All plants have red hypocotyls. This will facilitate studies in outcrossing involving tetraploids derived from self-fertile diploid inbreds.

Germinating seed of selection F58-554 (NB4) was treated with colchicine and planted in late October. This selection is a small-seeded, multigerm inbred. All plants have green hypocotyls.

In November 1962, germinating seed of selection 2559-1 was colchicine-treated. This selection is a multigerm inbred similar to NB1. Nearly 100 percent of the seedlings have red hypocotyls. This character will facilitate studies in outcrossing.

COMPARISON OF THE GAMETOCIDE PROPERTIES OF FW-450 AND FW-676

I. O. Skoyen

A field test in 1961 compared the gametocide properties of sodium 2,3-dichloroisobutyrate (FW-450) and a closely related chemical, FW-676.

Plants of the self-fertile multigerm NB 1 inbred were treated with the gametocides, and plants of a red beet derivative, developed by Holly Sugar Corporation, were used as a pollen source. Stecklings were transplanted March 24, 1961, and gametocide applications were started on May 15 when test plants were in early bud. Concentrations of 0.15 and 0.3 percent were used of each chemical. Gametocide applications were made to runoff with fresh aqueous solutions at 6- and 10-day intervals. The calculated application rate on an acre basis was 320 gallons per acre. Each treatment was made in a series of three applications.

Gametocide treatments started when test plants were in early bud produced sterile anthers in the first open flowers. Sterility appeared to be near maximum 10 to 15 days after the first treatment. Sterility was judged on the failure of anthers to dehisce, on discoloration, and on the reduced size and empty appearance of the anthers formed following treatment.

At harvest, on August 22, 1961, seed from two replications of the treated plots was separated into two lots for each plot. Seed was bulked together in one lot for each of the plots in the third replication. One lot was composed of mature seedballs and the other of maturing seedballs. This was done in order to estimate the duration of the sterilizing effects of the gametocides on treated plants. It was assumed that the mature seed was set 5 to 6 weeks before harvest and that a higher level of hybridization would indicate slight recovery and pollen shedding in treated plants. This would mean that pollination of the mature seed occurred during a 5-to 7-week period following the final gametocide application. The results showed higher cross-pollination in the mature seed, indicating little recovery and pollen shedding during the 5-to 7-week period (Table 1). (Previous tests in Sugar Beet Res.,1960 Rpt.,p.181.)

Hybridization between treated NB 1 plants and the red beet averaged 76 percent for all treatments compared to 0.5 percent hybrids with red beet on untreated plants (Table 1). Hybridization on plants treated at a 6-day interval with both chemicals averaged about 10 percent higher than that on plants treated at a 10-day interval. The results showed that hybridization of 75 to 85 percent may be obtained during the 5-to 7-week period of maximum sterility. However, scattered flowers usually shed some pollen throughout the period following treatment, and in the 1961 test, self pollination probably accounted for the 15 to 25 percent of the seed which was not hybrid.

In 1961, seed yields were higher for the 6-day treatment intervals than for the 10-day intervals for both chemicals and concentrations. Plots treated with 0.15 percent FW-450 at 6-day intervals averaged 41

percent higher in yield than the same treatment with FW-676 (Table 1). Although yield comparisons between treated and untreated plants of NB 1 were not available for the 1961 test, it was obvious from the damaged condition of all treated plants that the gametocide treatments caused severe yield reductions.

Germination was severely reduced in the 1961 field test and ranged from 37 to 66 percent below that of seed from untreated plants (Table 1). Germination of seed from plots treated with both concentrations of FW-450 at 6-day intervals was appreciably higher than that of seed from plots given the same treatments with FW-676. There was no difference in germination between chemicals or concentrations in plots treated at the 10-day interval.

Phytotoxic side effects such as contact burn, chlorosis followed by necrosis, and distorted growth of leaves and flower parts were similar for both chemicals. Chlorosis is generally less evident under field than greenhouse conditions, but branch tips often die back similarly although less extensively. Seed set occurs mainly on the lower parts of affected branches and on new branch growth and seldom on chlorotic branch tips.

SUMMARY

The 1961 field results of testing with FW-450 and FW-676 showed approximately 80 percent hybridization between NB 1 test plants and red beet in a 5-to 7-week period following the last gametocide application. Untreated plants of the self-fertile NB 1 inbred showed only 0.5 percent hybrids with red beet.

Treatments with the 0.15 percent concentrations of both chemicals at 6-day intervals produced slightly less effective pollen sterility than the 0.3 percent concentrations, but this was offset by reduced phytotoxic damage to seed yield and germination. Test results showed FW-450 was generally more effective than the FW-676 chemical.

Phytotoxic side effects such as contact burn, chlorosis followed by necrosis, and distorted growth and thickening of stems, leaves and flower parts were similar for both chemicals. The general phytotoxic damage to treated plants indicated that, with the use of runoff applications, concentrations could probably be reduced to 0.10 or 0.08 percent without serious loss of sterility effects and appreciably reduce phytotoxicity. Similar results could probably be achieved with the 0.15 percent concentration by reducing application rates.

The use of gametocides in commercial seed production appears impractical, because seed from treated plants is not completely hybrid and phytotoxicity causes serious reductions in yield and germination. However, gametocides are promising breeding tools, particularly in crossing and evaluating self-fertile breeding material. By emasculating one parent with a gametocide, crossing can be accomplished and hybrid performance tested early in the development of inbred lines. In this way, the time consuming incorporation of male sterility could be limited to the most promising material.

Table 1.--Summary of hybridization, germination, and seed yield obtained in 1961 field test of two gametocide chemicals.

Chemical and concentration	Treatment interval	Hybridization: Total of all seed per plot [1]	Hybridization: Mature seed	Hybridization: Maturing seed	Seed yield per plot	Seed germination
(Percent)	(Days)	(Percent)	(Percent)	(Percent)	(Grams)	(Percent)
FW-450						
0.15	6	71.2	78.5	47.2	52.0	53.2
0.3	6	75.2	83.5	64.3	11.8	36.8
FW-450						
0.15	10	61.5	56.5	37.8	34.2	29.6
0.3	10	78.6	60.1	35.4	9.5	25.6
FW-676						
0.15	6	60.2	77.4	22.2	30.6	30.0
0.3	6	80.2	86.4	--	11.7	24.0
FW-676						
0.15	10	65.2	75.3	54.3	26.3	28.0
0.3	10	58.4	69.4	33.3	5.0	27.5
MEAN (Excluding check)		66.1	76.2	42.1	22.6	31.8
Check		0.5			--	90.0

1/ Plots consisted of 3 plants each.

PART III

DEVELOPMENT AND EVALUATION OF INBRED LINES AND HYBRID VARIETIES OF SUGARBEETS

with emphasis on

Curly Top Resistance,
Monogermness, and High Quality

- - -

STUDIES ON GENETICS OF MALE STERILITY IN THE SUGARBEET

- - -

GREENHOUSE TECHNIQUES TO EVALUATE BREEDING MATERIAL FOR RESISTANCE TO CURLY TOP AND VIRUS YELLOWS

Foundation Projects 17, 21, and 27

F. V. Owen
A. M. Murphy
J. C. Theurer

G. K. Ryser
C. H. Smith
Myron Stout

Cooperators conducting field tests:

Utah Agricultural Experiment Station
Utah-Idaho Sugar Company

STUDIES OF MALE STERILITY IN SUGARBEETS[1/]

By J. C. Theurer, G. K. Ryser and E. H. Ottley

Major emphasis in 1962 has been directed towards planning and initiating experiments to study comprehensively the inheritance of male sterility in the sugarbeet.

Association of Cytoplasmic and Mendelian (aa) Male Sterility

F. V. Owen observed some unexpected associations between cytoplasmic and Mendelian types of sterility (1958 Report, p. 35). In 1962, stecklings were produced of the available progeny of the lines which gave exceptional results, and these lines will be used in further studies of inheritance.

Effect of Environment Upon Male Sterility

Stecklings of the male-sterile phase of inbreds and their corresponding "O" type pollinators, as well as stecklings of several hybrids, were produced this summer for use in environmental studies. Exploratory tests will be initiated in the greenhouse this winter to study the influence of such factors as temperature, moisture stress, and photoperiod on sterility. Stecklings of inbred lines will be used to obtain isogenic lines for future study. Critical studies on environment will await the installation of growth chambers in the Crops Research Laboratory.

1/ Research strengthened through contributions under Projects 17 and 21 of the Beet Sugar Development Foundation.

Asexual Transmission of Male Sterility

Studies with petunia have provided evidence that cytoplasmic male sterility can be transferred from one plant to another by the simple technique of grafting. At present, we are in the process of making grafts to test the possibility of using this technique in sugarbeet breeding.

Plant materials selected for use in this study include SLC 03 HO, annual male sterile, and SLC 03, the corresponding "O" type pollinator; SL 01107, annual male-sterile line with Ovana plasm; and the biennial "O" type pollinators SLC 129 and CT5 mm and their corresponding male-sterile lines. Several methods of grafting have been tried, and varied degrees of success have been attained with each. Forty succesful grafts have been produced to date in this study.

POLLEN RESTORER STUDIES

By J. C. Theurer and G. K. Ryser

Selected homozygous lines of beets which carry strong pollen restorer genes are valuable as a tool for determining the inheritance of male sterility. Owen and Ryser previously (1959 Report) presented data indicating that they had found a good pollen restorer line in progeny of the leaf spot resistant variety US 201.

Subsequently, a powerful restorer gene has been found in a selection of red table beets. Preliminary data on the latter selection are given below.

Three selected plants from the red table beet variety "Ruby Queen" were crossed to the annual male-sterile sugarbeet SLC 03 HO. The F_1, F_2, and b_1 generation of eight lines were grown in the greenhouse and classified for pollen fertility. Classification of each F_2 and b_1 plant of the most promising pollen restoring line was based on microscopic examination of stained pollen grains. Data for this line are given in the following table.

CLASSIFICATION OF PROGENY OF L 11120

F_1 (L 11120) = SLC 03HO X 0333-5, one plant of Ruby Queen

Generation	Male Sterile	Semi-Sterile	Fertile	Total	X^2	P
F_1	0	0	101	101	-	-
F_2 observed	124	224	109	457		
expected (3:1)	114.25	342.75			1.110	.30
b_1 observed	118	99	10	227		
expected (1:1)	113.5	113.5			.357	.50

The Chi square test indicates that pollen restoration was mainly due to a single dominant gene.

F_1 Generation L 11120 (SLC 03 HO X Ruby Queen)

All of the F_1 plants were vigorous annuals with red hypocotyl color. They were fairly uniform in pollen production and were all classified as completely fertile plants, based on visual observation of the flowers.

F_2 Generation L 11120 ⊗

The F_2 plants maintained good vigor and, as expected, approximately one-fourth of them produced only vegetative growth. One-fourth of the individual annual segregates were classified as fully fertile, having 90% or better stainable pollen. As expected, an equal percentage of the plants bore flowers with white anthers, similar to the SLC 03 HO parent. All degrees of fertility, from 2% to 90% stainable pollen, were found in the semi-sterile class.

b_1 Generation (SLC 03 HO X L 11120)

The b_1 plants were also quite vigorous, but pollen production was considerably less than in the F_1 generation. Only ten plants (4%) produced sufficient stainable pollen to be classified as fertiles. In addition, the majority of semi-sterile plants produced less than 50% viable pollen.

Comparison of L 11120 and the Restorer from US 201.

One F_2 family (L 11102) of the pollen restorer line derived from US 201 was planted in the greenhouse and observed under the same environment as L 11120. A majority of the plants had yellow anthers and shed pollen. However, on the average, the percent stainable pollen was considerably less than that found in the L 11120 population. Thus, it would appear

that the pollen restoring gene derived from the red table beet was stronger than the gene from US 201.

Anther Color and Percent Viable Pollen

Cutting a flower in cross section with a sharp knife and noting the color of the anthers is a common method used by breeders to determine the fertility of a plant. This procedure appears to be valid for selection of white anther male-sterile plants. However, it doesn't give a clear indication of the degree of viable pollen of a plant having yellow anthers. Some plants observed in this study had slightly shrunken but dark-yellow anthers and were visually classified as semi-steriles. When pollen from these plants was observed microscopically they were classified as completely sterile. In certain cases, even plants classified as fertiles which were profusely shedding pollen were found to have as high as 50% to 60% small, unstained sterile pollen.

This emphasizes the fact that microscopic examination of pollen and not just visual observation is required when one endeavors to elucidate the complex interaction of genes, cytoplasm, and environment that conditions male sterility.

A RAPID INDIVIDUAL BEET SELECTION METHOD

By J. C. Theurer, Myron Stout, and G. K. Ryser

A method has been developed whereby the breeder can select individual beets of high quality and at the same time retain the beets for breeding purposes. Eight lines were grown this past season and evaluated by this rapid technique. Information thus obtained relative to variation in individual lines showed that nearly all of the superior beets in a line could be selected by extensive evaluation of but 1% of the field population.

METHODS:

Prior to harvest, the tops were removed from the beets by passing over the field twice with a tractor-mounted rotobeater. Then all non-competing beets, those not surrounded by adjacent plants of 2 feet or less spacing within or between rows, were crowned, using long-handled hoes. The beets were lifted with an International harvester and elevated to a 4-inch mesh rubberized screen placed over the harvester bin. Ten percent of the field population of each line was selected on the basis of root size and shape by two men riding on the harvester. The selected beets were washed, bagged, and placed in cold storage to await laboratory analysis.

In the laboratory, each individual beet was weighed and numbered. The conical drill and transverse plug methods reported in 1954 (Proc. A.S.S.B.T. 8(2):410-416) were used for chemical and physiological sampling. Abbe refractometric readings were made and recorded on each beet below the beet number. Chemical determinations were made on all selected beets, but only the top ten percent of each line, based on the Abbe reading, was tested for respiration rate.

A breakdown of the operations used in the present study is given in Table 1, showing (1) personnel requirements and (2) efficiency of the laboratory procedures.

RESULTS AND DISCUSSION:

In this study, chemical testing was done on all beets to evaluate the reliability of the preliminary selection based on dry substance. Usually, only those shown to be superior by means of the Abbe refractometer need be more completely tested. This is shown by the fact that 85% of the final selection of outstanding beets were among those having high dry substance. Furthermore, this percentage could have been improved by preventing surface drying before testing. The Abbe sample was taken from the outside inch of tissue, while the B and L sample was taken from the central part of the beet. Table 2 shows that the Abbe reading was over 3% higher than that of the B and L sample.

Comparison of the data in Tables 2 and 3 shows the improvement made in selecting beets by means of the Abbe refractometer, in addition to field selection for large size and good shape. The data show large coefficients of variability in amino N, Na, K, respiration rate, sugar content, and weight, even though small beets were eliminated by field selection. Average variation in sugar percentage was quite small, being greatest in 431+5 (b_1 of US35/2 X Ovana fodder beet). The coefficient of variability for respiration rate was fairly large, indicating a good possibility of improving lines with respect to this character also. The Abbe selections were consistently higher in weight, sugar percentage, and sugar content. They were consistently lower in sodium. In most cases they were lower in amino N and higher in potassium. A final selection, based on all characters evaluated, showed some very out-

standing beets. Several were higher than 20% sugar and relatively low in impurities. Inasmuch as the superior individual beets have not been lost in the selection process, they can be thermally induced and further used in the breeding program.

Data in Table 4 show that potassium and sugar content were consistently correlated with beet weight for all varieties. Some varieties also showed significant correlations between beet weight and the other characters studied. However, no association was noted between beet weight and sugar percent for any variety.

Sugar percent was significantly correlated with sodium, potassium, and in some varieties, with amino nitrogen. All of the other variables were highly positively correlated with sugar percentage, as would be expected, since they are directly affected by this factor. Of interest was the observation that the low sugar variety 431+5 showed the highest correlation between sugar percent and apparent purity.

TABLE 1. Time and personnel requirements in laboratory testing of individual sugar beets.

Operation1/	Personnel Required	Beets Per Day	% of Field Population Analyzed
I. Weighing, numbering and recording Abbe refractometric solids on each beet.	5	500	10
II. Core sampling and weighing sample	3	500	
Blending (2 blenders)	2	500	
Leading and filtering	1	500	
Polarization (sugar)	1	500	
Amino nitrogen	2	500	
Diffusate dry substance (B and L Refr.)	2	500	
Washing Dishes	1	500	
III. Sodium (flame spectrophtometer)	3	1200	
IV. Potassium (flame spectrophtometer)	3	1200	
V. Respiration rate	2	56	1

1/ Each operation, I through V, may be done separately. A maximum of 12 people is needed at any one time.

TABLE 2. Variation in individual beets selected for root size and shape.

Number of Beets Variety	326 1200	199 1204	179 1206	264 1207	154 0223	136 0504	155 0548	66 431+5
				Beet Weight Dkg. Code 1				
Mean	124.17	121.45	136.40	125.40	151.11	117.28	132.39	195.47
S.D.	39.68	32.41	40.53	27.34	33.97	29.43	35.52	36.09
C.V.%	31.96	26.68	29.71	21.80	22.48	25.09	26.84	18.46
				% Sugar in Beet Code 2				
Mean	17.09	16.50	15.95	15.84	16.25	15.92	14.78	13.85
S.D.	1.18	1.36	1.22	1.63	1.37	1.70	1.37	1.87
C.V.%	6.90	8.24	7.65	10.29	8.43	10.68	9.73	13.50
				Amino N PPM in Beet Code 3				
Mean	2010	2115	3061	2117	2082	2048	2357	4308
S.D.	857	1056	1556	936	1059	861	969	1912
C.V.%	42.63	49.93	50.83	44.21	50.86	42.04	41.11	44.38
				Na PPM in Beet Code 4				
Mean	104	77	85	58	58	72	112	206
S.D.	65	33	46	32	33	48	68	102
C.V.%	62.42	43.02	54.00	55.35	56.03	67.29	60.93	48.99
				K PPM in Beet Code 5				
Mean	1358	1144	1512	1307	1220	1483	1775	3130
S.D.	409	328	503	368	363	463	405	602
C.V. %	31.29	28.66	33.93	28.19	29.74	31.25	22.80	19.22
				Percent Solids by Abbe Refractometer Code 6				
Mean	21.40	21.12	20.09	20.93	20.75	20.23	18.49	18.33
S.D.	1.63	1.17	1.66	1.78	1.38	1.73	1.39	1.75
C.V.%	7.62	5.53	8.26	8.50	6.65	8.55	7.52	9.55
				Sugar Content Gms. Code 7				
Mean	211.28	200.01	216.97	198.74	345.50	185.44	195.58	269.52
S.D.	66.69	55.64	65.89	50.74	61.67	47.74	58.08	56.12
C.V.%	31.56	27.81	30.37	25.53	17.85	25.74	29.70	20.82
				Diffusate Solids by B and L Refractometer Code 8				
Mean	18.27	17.46	17.06	16.64	17.46	17.19	16.24	15.84
S.D.	1.09	1.40	1.17	1.56	1.35	1.57	1.29	1.64
C.V.%	5.97	8.02	6.86	9.40	7.73	9.13	7.94	10.35
				B and L Refractometer Reading Code 9				
Mean	23.18	22.79	22.26	22.24	22.78	22.66	22.19	22.01
S.D.	0.52	0.67	0.57	0.75	0.65	0.75	0.62	0.79
C.V.%	2.24	2.94	2.56	3.37	2.85	3.31	2.79	3.59
				Percent Apparent Purity Code 10				
Mean	93.51	94.45	93.50	95.24	93.06	92.55	90.93	87.17
S.D.	2.43	2.12	3.27	3.65	2.40	3.53	3.15	4.85
C.V.%	2.60	2.24	3.50	3.83	2.58	3.83	3.46	5.57

TABLE 3. Variation in selected individual beets selected for root size, shape, and high sugar.

Number of Beets	32	20	16	23	13	11	10	13
Variety	1200	1204	1206	1207	0223	0504	0548	431+5
	Respiration of Individual Beets Code 11							
Mean	112	103	122	130	107	119	92	110
S.D.	13.34	12.73	12.41	21.02	14.89	18.46	14.83	15.78
C.V.%	11.85	12.32	12.01	16.17	13.92	15.54	16.22	15.40
	Beet Weight Dkg. Code 1							
Mean	142	134	159	147	179	144	170	217
S.D.	34.40	27.76	30.56	25.87	38.04	26.23	36.01	39.52
C.V.%	24.27	20.72	19.22	17.60	21.25	18.21	21.18	18.21
	Percent Sugar in Beet Code 2							
Mean	18.78	18.99	17.42	18.93	18.26	18.39	16.71	15.12
S.D.	1.13	1.08	1.30	0.84	0.96	1.01	1.18	1.17
C.V.%	6.02	5.69	7.46	4.44	5.26	5.49	7.06	7.74
	Amino N PPM Code 3							
Mean	1819	2810	2506	2065	2415	2227	1710	3715
S.D.	303	1889	1104	668	1245	569	242	1755
C.V.%	16.66	67.22	44.05	32.35	51.55	25.55	14.15	47.24
	Na PPM in Beet Code 4							
Mean	50	45	51	39	53	55	64	148
S.D.	24	29	23	12	17	14	20	72
C.V.%	48.00	64.44	45.10	30.77	32.08	25.45	31.25	48.65
	K PPM in Beet Code 5							
Mean	1403	1161	1515	1394	1417	1544	1691	2973
S.D.	549	219	423	421	339	267	308	742
C.V.%	39.13	18.89	27.92	30.20	23.92	17.29	18.21	24.96
	Sugar Content Gms. Code 7							
Mean	266	260	269	274	319	257	300	317
S.D.	43	45	30	45	43	30	68	45
C.V.%	16.16	17.30	11.15	16.42	13.48	11.67	22.67	14.20

TABLE 4. Correlations between beet weight, sugar percentage, and other variables.

Number of Beets	326	199	179	264	154	136	155	66
Variety	1200	1204	1206	1207	0223	0504	0548	431+5
				Beet Weight				
2.	-.099	.014	-.039	.114	.105	-.170	.086	-.116
3.	.334**	.135	.047	.044	.158*	.216	.073	.215
4.	.158*	.052	.098	.069	.087	.304*	.041	.082
5.	.445**	.436**	.388**	.336**	.292*	.471*	.381*	.468**
6.	-.137*	.067	-.146	.075	.031	.100	.160*	.017
7.	.973**	.950**	.964**	.907**	.936**	.896**	.939**	.771**
8.	-.078	.046	.076	.148*	.149*	-.110	.079	-.046
9	-.080	.045	.092	.147*	.149*	-.110	.079	-.046
10.	-.089	-.120	-.231**	-.074	.111	-.234	.100	-.174
				Sugar Percentage				
1.	-.099	.014	-.039	.114	.105	-.170	.086	-.116
3.	-.256**	-.028	-.403**	-.071	-.144	-.125	-.374*	-.236
4.	-.528**	-.546**	-.498**	-.515**	-.486**	-.642**	-.464*	-.569**
5.	-.278**	-.145	-.295*	-.069	-.256*	-.373**	-.237**	-.416**
6.	.642**	.591**	.520**	.685**	.640**	.794**	.583**	.821**
7.	.122*	.319**	.218**	.515**	.442**	.274*	.409**	.533**
8.	.928**	.964**	.894**	.932**	.955**	.939**	.928**	.926**
9.	.932**	.960**	.889**	.932**	.955**	.939**	.928**	.926**
10.	.521**	.255**	.438**	.378	.388**	.540**	.542*	.756**

* Significant at 5% point.
** Significant at 1% point.

1.= Beet weight
2.= Percent sugar
3.= Amino nitrogen
4.= Na
5.= K
6.= Abbe refractometer
7.= Sugar content
8.= Percent solids
9.= B and L Refractometer
10.= Percent apparent purity

TETRAPLOIDS IN SUGAR BEETS THROUGH COLCHICINE TREATMENT OF SEED

By C. H. Smith

With the experiences of other workers as a guide, the following procedure for obtaining tetraploids in sugar beets through seed treatment was outlined. Colchicine solutions of 0.1% and 0.5% strength were used with the length of treatment, six and sixteen hours at each strength. Treatments of dry seed and pregerminated seed were also compared at the two strengths and at the two lengths of treatment. Dry seed was treated in colchicine solution, washed in two changes of water, and planted. Pregerminated seed was first washed for three hours in running water, pregerminated at 75° F. for 36 hours, treated with colchicine solution, washed in two changes of water, and planted.

Five varieties of sugar beets showing the greatest degree of tolerance to nematodes were used in the first test. The complete plan of the treatment is shown in Table 1. Two varieties indicated fast germination qualities by the appearance of many white root tips during either the pregermination period or colchicine treatment period.

The effect of colchicine on young seedlings was expressed in the deformity of cotyledons, the first two leaves, or by the thickening of the hypocotyls. Seedlings not showing at least one of these characteristics were removed. The remainder of the seedlings were allowed to grow for two months and were then placed in a cold storage chamber at 36° to 40° F. for thermal induction. After six weeks to two months, the small beets will be returned to the greenhouse to induce seedstalk growth. Pollen grain size will be the next step in determining tetraploidy in the plants and in making further selections.

Dry seed treated with colchicine produced less plants showing the effects of the treatment than did the pregerminated samples. Treatments with 0.5% colchicine produced more deformity than those with 0.1%. Likewise, the greater length of treatment produced greater effects on the seedlings. In most instances, samples showing greater effects of the colchicine on the seedlings were not only slowed up in germination but the resulting seedlings were smaller in size. Most of the abnormal characteristics showing up on treated seedlings disappeared as growth continued.

A second group of five curly-top resistant numbers was treated with a 0.5% solution of colchicine for 16 hours on pregerminated seed. The procedure and results were similar for a like-treatment of the previous test. Other curly-top-resistant numbers are being prepared for treatment.

Table 1

	VARIETY NUMBER	DRY SEED 6-HOUR TREATMENT		DRY SEED 16-HOUR TREATMENT		PREGERMINATED SEED 6-HOUR TREATMENT		PREGERMINATED SEED 16-HOUR TREATMENT	
		0.1%	0.5%	0.1%	0.5%	0.1%	0.5%	0.1%	0.5%
9132 rr mm X 924 etc. CT5 mm	0179	1	2	3	4	5	6	7	8
9145 mm MS (SLC 129) X Group A Nema. Sel.	0198	9	10	11	12	13	14	15	16
833-1	00.15	17	18	19	20	21	22	23	24
7121 mm MS X 805 of CT5 mm	9140	25	26	27	28	29	30	31	32
85.267 H44 X 8755 mm (SLC 129)	9145	33	34	35	36	37	38	39	40

VARIETY TEST, LOGAN, UTAH, 1962

By G. K. Ryser

The varieties in these tests represent Dr. F. V. Owen's latest "O" type breeding material and hybrid combinations. All variety tests at Logan were planted in a 1-1/2 acre strip on the Greenville Farm, Utah State University.

SOIL TYPES: Silty clay loam.

PREVIOUS CROPS: Alfalfa, 7 years; 1961, safflower.

FERTILIZERS: 400# per acre of ammoniated phosphate (20-40) per acre broadcast in the spring before planting then harrowed.

PLANTED: April 17, 1962.

THINNED: May 24 to May 28, 1962.

IRRIGATIONS: Weekly, starting July 5, 1962.

CURLY TOP: Symptoms were noted in susceptible varieties only.

HARVESTED: October 15, 1962. Tops were removed with a roto-beater and scalped with tractor-mounted scalping tools, supplemented by long-handled hoe trimming, to assure a complete topping job. Beets in a plot were counted after scalping before lifting with the harvester. Ten-beet samples from both rows of each plot were obtained for sugar analysis, and all beets were weighed to determine yield per acre.

EXPERIMENTAL DESIGN: Test I was planted as an 8 X 8 Latin square, but the last replication was so poor, due to some soil condition, that it was discarded. Test II was planted as a randomized block with 20 varieties and three replications. All other variety plots were for observation only. Strip plantings were made on what was considered to be some of Dr. Owen's best "O" type material for reselection. Varieties 1200, 1204, 1207 and 0223 were planted in 5-row strips; and varieties 1206, 0504, 0548 and 431+5 were planted in 2-row strips.

VARIETY TEST, LOGAN, UTAH, 1962

7 replications of each variety TEST I

S. L. NUMBER		ACRE YIELD GROSS SUGAR	ACRE YIELD TONS BEETS	PERCENT SUGAR	PERCENT PURITY	PPM Amino N	PPM Na	PPM K	BEETS 100'
1101	0157# X 0457	11,116	35.3	15.8	87.2	3000	68	1499	94
1102	0158 X do.	10,015	31.3	15.9	88.0	3300	71	1427	96
1103	0166 X do.	10,343	31.3	16.5	89.1	3000	60	1362	80
1104	0168 X do.	10,471	32.2	16.3	89.1	3500	66	1413	89
1105	0173 X do.	10,280	31.7	16.2	88.0	3300	68	1564	91
1106	0180 X do.	10,011	31.2	16.1	88.0	3800	64	1547	88
1341	(CT9 mm X AI-9)##	9,697	29.2	16.6	88.8	2500	55	1443	83
1342	SLC128 X (CT5XCT9)###	9,177	28.5	16.1	89.6	4200	76	1458	93
General MEAN of all varieties		10,139	31.3	16.2	88.5	3325	66	1464	
S. E. of MEAN		298	0.88	0.22	0.60	236	1.7	53	
Sig. Diff. (19:1)		NS	2.52	NS	NS	674	NS	NS	
S. E. of MEAN in % of MEAN		-	2.81	-	-	7.10	-	-	
Calculated F Values			3.73**			2.77*			

\# Female Parent - male sterile and monogerm, see descriptive sheet.

\## Amalgamated Sugar Co. variety.

\### Utah Idaho Sugar Co. variety.

VARIETY TEST, WEST JORDAN, UTAH, 1962

By Utah Idaho Sugar Co.

8 X 8 Latin square TEST I

S. L. NUMBER		ACRE YIELD Gross Sugar lbs.	ACRE YIELD Tons Beets	PERCENT Sugar
1101	0157 MS mm X (630 X CT5)	9,246	34.40	13.44
1102	0158 MS mm X do.	9,206	33.02	13.94
1103	0166 MS mm X do.	9,507	32.38	14.68
1104	0168 MS mm X do.	9,586	33.08	14.49
1105	0193 MS mm X do.	9,481	32.47	14.60
1106	0180 MS mm X do.	9,234	32.04	14.41
1341#	CT9 MS mm X AI-9	9,349	31.67	14.76
1342##	SLC 128 X (CT5 X CT9)	9,259	31.93	14.50
General MEAN of all varieties		9,359	32.62	14.35
S. E. of MEAN		370	1.22	0.16
Sig. Diff. (19:1)		NS	NS	.45
S. E. of MEAN in % of MEAN				1.11
Calculated F values				7.90**

Amalgamated Sugar Co. variety.

Utah Idaho Sugar Co. variety.

Male-Sterile Monogerm Female Parent

9132 = (SLC 133 MS mm X SLC 131)

9142 = [(SLC 127 MS mm X SLC 129) X Sugar Selection (mm)]

0151 = [(SLC 127 X SLC 129) X SLC 127]

0156 = [(SLC 127 X SLC 129) X CT5 mm]

0157 = [(SLC 129 X SLC 129) X Sugar Selections mm]

0158 = [(SLC 127 X SLC 129) X 7125]

0160 = [(SLC 177 X SLC 129) X (SLC 132 X SLC 129)]

0166 = SLC 129 MS mm

0168 = [(SLC 129 X SLC 130) X SLC 128]

1073 = [(Rush (10 X 12) X SLC 129)]

0179 = [(SLC 133 X SLC 129) X (SLC 132 X SLC 129)]

0180 = SLC 128

Pollinators

0267 = SLC 129-0 X CT5 mm

0453 = CT5 B-0 X 631+a

0457 = 630 aa X CT5 mm+a

VARIETY TEST, LOGAN, UTAH, 1962

3 replications each variety TEST II

S. L. NUMBER		ACRE YIELD GROSS SUGAR	ACRE YIELD TONS BEETS	PERCENT SUGAR	PERCENT PURITY	PPM Amino N	PPM Na	PPM K	BEETS 100' ROW
1114	9132# X CT5 mm	11,602	35.8	16.2	90.3	3000	60	1395	88
1113	9132 X CT5 B MM	10,941	33.1	16.5	89.2	3000	52	1370	91
1107	9142 X 0453 MM	10,540	33.7	15.8	90.4	3000	65	1462	83
1109	0166 X 0453 MM	10,470	31.2	16.8	91.3	2100	45	1451	93
1131	0179 X (CT5 mm)	10,251	31.9	16.1	89.0	2500	53	1448	80
1110	0168 X 0453 MM	10,180	32.2	15.8	81.8	3600	73	1404	93
1111	0173 X 0453 MM	9,821	30.0	16.4	89.9	2800	58	1420	104
1125	0160 X (F_3b_2CT5 mm)	9,786	30.4	16.0	89.9	2500	61	1424	75
1112	0180 X 0453 MM	9,549	29.4	16.8	89.9	2100	46	1289	81
1127	0157 X SLC 127	9,412	30.3	15.7	88.6	2100	65	1337	76
1130	0156 X (CT5 mm)	9,415	29.6	15.9	89.5	2600	65	1343	83
1120	0156 X CT5 mm (F_2b_2)	8,994	27.9	16.1	91.7	2400	55	1311	88
1108	0158 X 0453 MM	8,961	27.0	16.6	89.0	2400	52	1257	87
1128	0156 X CT5 mm (F_3b_2)	8,916	27.8	16.0	88.7	2500	56	1364	71
1122	0166 X 0267	8,897	28.7	15.5	89.8	2500	77	1404	94
1123	0156 X SLC 132	8,882	29.7	15.0	90.2	2500	108	1577	72
1124	0156 X (F_2b_2CT5 mm)	8,790	28.0	15.7	90.0	2700	69	1412	80
1121	0156 X 0267	8,619	26.8	16.0	89.4	2700	57	1246	93
1129	0156 X SLC 129	8,392	25.2	16.7	90.3	2800	44	1509	78
1126	0151 X SLC 127	7,920	24.8	16.0	89.8	2200	82	1469	72
General MEAN of all varieties		9,527	29.7	16.1	89.4	2600	62	1395	
S. E. of MEAN		440	1.37	0.28	0.98	342	9	60	
Sig. Diff. (19:1)		1263	3.93	0.80	NS	NS	25	173	
S. E. of MEAN in % of MEAN		462	4.61	1.74	-	-	14.52	4.30	
Calculated F Values		4.54**	4.21**	2.62**			2.97**	1.93*	

\# All female parents male sterile and monogerm - see descriptive sheet.

VARIETY OBSERVATION PLOTS, 1962

* One replication only.
Others have two replications

S. L. NUMBER		ACRE YIELD GROSS SUGAR	ACRE YIELD TONS BEETS	PERCENT SUGAR	PERCENT PURITY	PPM Amino N	PPM Na	PPM K	BEETS 100' ROW
				Inbred Hybrids					
*1208	CT5 mm X SLC 128	8,093	28.1	14.4	90.8	1800	102	1384	67
0548	SLC 129 X SLC 132	7,079	26.6	13.3	86.3	2800	130	1746	75
GENERAL MEAN		7,586	27.35	13.85	88.55	2300	116	1565	
				Sib Combinations					
1450	9450 aa X 9450 + a	8,382	27.0	15.5	91.3	2900	106	1249	93
1205	SLC129 05.29.1Xsibs	7,348	24.4	15.1	90.2	2000	86	1306	64
1204	05.24.1 etc. X sibs	7,138	23.2	15.4	91.0	3000	84	1388	73
1200	aa's Denney	6,976	22.3	15.8	90.3	1800	114	1371	74
*1451	02.55.1 aa X sibs	6,463	21.4	15.1	89.2	2800	71	1384	85
1207	0267 aa X sibs	5,780	18.5	15.6	89.6	2900	69	1432	92
0223	CT5 mm-0 X sibs	5,547	18.2	15.3	87.1	2300	75	1170	72
*1206	CT5 mm-0 05.24.2 etc. X sibs	3,866	12.8	15.1	90.0	2000	95	966	55
*1210	0223 aa X sibs	3,810	12.7	15.0	91.6	1400	58	1272	39
*1203	05.126.6 etc. X sibs	3,161	10.9	14.5	87.3	1800	106	1446	24
*1209	0551 etc. X sibs	2,850	9.5	15.0	90.2	1800	50	1208	25
GENERAL MEAN		5,574.6	18.26	15.22	89.8	2245	83	1290	
				Inbreds					
*5071	CT7 sister lines	6,570	22.5	14.6	87.6	4700	66	1200	97
5090	CT9	6,431	20.4	15.8	91.2	2700	114	1247	89
5070	CT7	6,202	20.4	15.2	83.1	4800	72	1194	104
GENERAL MEAN		6,401	21.1	15.2	87.3	4067	84	1214	
				aa's O.P.					
*1202	01.11 etc. aa OP	5,573	17.2	16.2	89.2	1800	41	1250	60
*0504	SLC 129 (9202) OP	5,155	17.3	14.9	90.3	1800	106	1165	91
1604	0553 OP (CT5 mm)	3,272	10.9	15.0	89.8	1900	62	1288	49
*1602	0523 OP (CT5 mm)	2,916	10.8	13.5	90.0	1500	74	1262	37
GENERAL MEAN		4,229	14.0	14.9	89.8	1750	71	1241	

THATCHER, UTAH - THE NEW LOCATION OF THE CURLY TOP SCREENING FIELD

By Albert M. Murphy

The first curly top screening plot of the Twin Falls Laboratory was established near Castleford, Idaho, in 1929. Later the work was moved to an area north and east of Buhl, Idaho. Because of the increase in land rental in that area, brought on by World War II, the operation was transferred to Jerome, Idaho, in 1943. The plot was located about 7 miles north of Jerome from 1943 through 1962.

The Twin Falls Laboratory was officially moved to Logan, Utah, January 1, 1962. The transfer was made without interruption of research in screening for curly top resistance.

Historically the incidence of curly top is low in the immediate vicinity of Logan. For this reason, it was deemed advisable to search for a suitable location for a plot in the Bear River Valley where curly top is a recognized hazard to susceptible crops.

By diligent searching in the spring of 1962, a fairly suitable 7-acre field was found at Thatcher, Utah, near the desert breeding area of the beet leafhopper and a distance of about 40 miles from the Logan Laboratory. The available land was almost twice as much as required for sugarbeet tests, but Dr. Mark W. Martin, Tomato and Cucurbit Investigations, Crops Research Division, ARS, also stationed at Logan, needed approximately 3 or 4 acres for his tomato curly top screening test. Since the farmer would not rent us the part of the field needed for sugarbeets, the entire field was rented and rental cost and operating expenses were divided as equally as possible with Tomato Investigations. The arrangement worked out very well.

By following methods developed over many years, with certain modifications to fit local conditions, a satisfactory curly top exposure was obtained.

Strips of susceptible Klein E material were planted the last of April. Mother beets infected with curly top virus were transplanted at intervals within these strips, also in April. The breeding material to be evaluated was planted June 12 and 13. The plots varied in size, depending on the amount of seed available. Most plots were 2 rows wide and 50 feet long, but some were 1-row, 50 feet long, and a few were only 1-row, 25 feet long.

Breeding material was tested for the following beet sugar companies: Utah-Idaho Sugar Company, The Great Western Sugar Company, and American Crystal Sugar Company.

Breeding material was tested for the following ARS investigators: G. E. Coe, J. O. Gaskill, J. S. McFarlane, F. V. Savitsky, and F. V. Owen and associates.

A few plants outstanding in curly top resistance were selected from breeding material furnished by American Crystal Sugar Company and The Great Western Sugar Company. These selections were shipped to the respective Company. In addition, selections were made from some of the breeding material of Dr. Coe, Dr. Owen and associates, and Dr. Savitsky.

It would not be feasible to report data obtained on all material tested, but it does seem pertinent to furnish in Tables 1, 2, and 3 the curly top percentage and grade of the varieties included in tests reported by G. K. Ryser. See pages 74-79.

Information on curly top evaluations of other breeding material is given in separate reports of the investigators.

TABLE 1. Percent curly top and curly top grade in same varieties as in Test I at Logan. Test planted June 12, 1962.

S. L. NUMBER		% CURLY TOP SEPTEMBER 1	CURLY TOP GRADE# AT END OF SEPTEMBER
1101	0157 X 0457	18.9	1.5
1102	0158 X do.	20.2	1.0
1103	0166 X do.	24.9	1.5
1104	0168 X do.	23.1	1.5
1105	0173 X do.	40.2	2.5
1106	0180 X do.	22.6	1.5
1341	(CT 9 mm X AI-9)##	not tested at Thatcher	
1342	SLC 128 X (CT5 X CT9)###	42.6	2.0

\# Curly top grade: 0 (healthy) to 9 (death due to curly top).

\## Amalgamated Sugar Co. variety.

\### Utah Idaho Sugar Co. variety.

TABLE 2. Percent curly top and curly top grade in same varieties as in Test II at Logan. Test planted June 12, 1962.

S. L. NUMBER		PERCENT CURLY TOP September 1	CURLY TOP GRADE END OF SEPTEMBER
1114	9132# X CT5 mm	16.9	1.5
1113	9132 X CT5 B MM	28.0	2.0
1107	9142 X 0453 MM	30.8	1.5
1109	0166 X 0453 MM	42.7	2.5
1131	0179 X (CT5 mm)	23.4	2.0
1110	0168 X 0453 MM	34.7	2.0
1111	this variety not included in Thatcher test.		
1125	0160 X (F_3b_2CT5 mm)	28.6	2.0
1112	0180 X 0453 MM	38.1	1.5
1127	0157 X SLC 127	60.3	3.5
1130	0156 ? (CT5 mm)	36.0	2.5
1120	0156 X CT5 mm (F_2b_2)	24.2	2.5
1108	0158 X 0453 MM	33.0	2.0
1128	0156 X CT5 mm (F_3b_2)	32.7	2.5
1122	0166 X 0267	36.2	3.5
1123	0156 X SLC 132	30.2	2.0
1124	0156 X (F_2b_2CT5 mm)	31.4	2.5
1121	0156 X 0267	35.2	2.5
1129	0156 X SLC 129	57.0	3.5
1126	0151 X SLC 127	65.6	4.0
Check	U.S. 33	100.0	6.0

All female parents male sterile and monogerm.

TABLE 3. Percent curly top and curly top grades in some of the varieties that appeared in the observation plots at Logan. Test planted June 12, 1962.

S. L. NUMBER		PERCENT CURLY TOP SEPTEMBER 1	CURLY TOP GRADE END OF SEPTEMBER
	Inbred Hybrid		
*1208	CT5 mm X SLC 128	23.4	2.0
	Sib Combinations		
*1450	9450 aa X 9450 + a	45.5	3.0
1205	SLC 129 05.29.1 X sibs	61.3	4.5
*1204	05.24.1 etc. X sibs	30.1	3.5
*1200	aa's Denney	35.8	3.5
*1451	02.55.1 aa X sibs	35.8	2.5
*1207	0267 aa X sibs	41.5	3.5
1210	0223 aa X sibs	29.3	2.5
*1209	0551 etc. X sibs	20.4	3.0
Check	U.S. 33	95.6	7.0
Check	U.S. 41	66.2	4.0
	aa's O.P.		
*1604	0553 OP (CT5 mm)	16.0	2.5
*1602	0523 OP (CT5 mm)	24.4	3.0

* Selections made.

GREENHOUSE TESTS OF CURLY TOP RESISTANCE

By C. L. Schneider

In 1962, studies were initiated at the Logan station toward the development of methods to evaluate and select sugarbeet strains for resistance to curly top under controlled conditions in the greenhouse. The studies include: Methods of maintaining nonviruliferous stocks of the insect vector; isolation and identification of curly top strains used in inoculation tests; determination of the effects of various environmental factors affecting the development of curly top and how to manipulate them to the degree where differences in curly top resistance can clearly be recognized.

Materials and Methods

Non-viruliferous cultures of the sugarbeet leafhopper were obtained by caging field collections on Australian salt bush, *Atriplex semibaccata*. Newly hatched nymphs were subsequently transferred from salt bush to salt bush and then to sugarbeet plants grown from seed in the greenhouse. Colonies are maintained in large glass and screen cages and in smaller single-leaf cages of plastic and organdy.

In inoculation experiments, non-viruliferous adult leafhoppers were placed on leaves of curly-top-infected plants for at least three days. The insects were then singly transferred to small glass cages, as described by Giddings (2). These were attached to leaves of seedlings for approximately seven days then removed. The seedlings were grown in 6-inch pots of sandy loam, four to a pot. Plants of other species were grown in 4-inch pots. Greenhouse temperatures were maintained at an average temperature of about 75° F. Approximately five weeks after inoculation, each plant was classified according to severity of curly top symptoms. The method of classification

employed was similar to that described by Giddings (1).

Isolation of Curly Top Strains

At the outset, it was deemed desirable to identify and classify the virus strains to be used in greenhouse screening tests. Attempts were made, therefore, to isolate strains from among the mass cultures of the virus collected from plants of resistant strains that showed curly top symptoms. These plants were selected among plants that were inoculated in the greenhouse and among those naturally infected in field plots at the curly top nursery at Thatcher, Utah.

Non-viruliferous leafhoppers were caged on these plants, then were transferred serially at approximately 12-hour intervals to sugar beet seedlings and to some plants of other species. Table I shows the degree to which insects infested with each mass culture transmitted curly top and the relative virulence of each culture. Additional cultures are presently being similarly tested.

Plants with severe curly top symptoms among the more resistant varieties are selected as sources of inoculum for inoculation tests, as it is less likely that they would contain mixtures of curly top strains to the extent that the plants with the original mass cultures would. Cultures from the plants thus selected are being tested on differential hosts in order to classify them according to pathogenic strains. The test hosts include those employed by Giddings (3), including resistant and susceptible sugar beet strains, Turkish tobacco, and beans. In addition, other species are also being tested for suitability as differential hosts.

Inoculation Tests

In a series of tests conducted at different times, sugar beet varieties that differ greatly in susceptibility to curly top were inoculated separately with several cultures of the virus. Included were highly resistant varieties U.S. 22/4 and S.L. 68, moderately resistant U.S. 75, and highly susceptible S.L. 742.

As shown in Table 2, each test clearly demonstrated the wide differences in curly top resistance among varieties such as U.S. 22/4 and S.L. 742. The degree of resistance representative of less resistant varieties, such as U.S. 75, was not readily apparent under the conditions that prevailed. Studies are presently being directed toward a methodology that would permit such a differentiation. The tests also indicate differences in virulence among the virus collections that were employed.

LITERATURE CITED

1. Giddings, N. J., 1937. A greenhouse method for testing resistance to curly top in sugar beets. Phytopathology 27:773-779.

2. _______________, 1939. A small cage for insect vectors used in plant inoculations. Phytopathology 29:649-650.

3. _______________, 1944. Additional strains of the sugar beet curly top virus. Jour. Agr. Res. 69:149-157.

TABLE 1. Results of serial transfers of single sugar beet leafhoppers from curly-top-infected sugar beets to seedlings of sugar beets, tobacco and *Chenopodium murale*.

Curly Top Culture No.	No. of Insects	S.L. 742: No. Plants In Each Curly Top Severity Class1/				S.L. 742: Total No. Plants	S.L. 742: Average Incubation Period (days)2/	U.S. 22/4: No. Plants In Each Curly Top Severity Class1/				U.S. 22/4: Total No. Plants	U.S. 22/4: Average Incubation Period (days)2/	Turkish Tobacco: No. Plants Infected	Turkish Tobacco: No. Plants Inoculated	*Chenopodium murale*: No. Plants Infected	*Chenopodium murale*: No. Plants Inoculated
		0	1-2	3-4	5-6			0	1-2	3-4	5-6						
1	13	-	-	-	-	-	-	30	6	9	1	46	13.0	2	5	0	9
2	4	-	-	-	-	-	-	3	1	0	3	7	8.5	-	-	0	2
3	9	1	0	0	4	5	9.0	35	6	6	3	50	13.6	-	-	0	2
4	10	4	0	2	0	6	9.5	46	1	8	4	59	11.9	2	5	0	4
5	7	2	0	0	1	3	12.0	29	0	2	0	31	17.5	0	3	0	2
7	3	-	-	-	-	-	-	11	0	2	0	13	10.5	0	1	1	1
8	12	6	0	2	2	11	10.0	41	6	5	1	53	14.2	2	5	0	1

1/ Curly top severity classes range from 0 (no symptoms) to 6 (dead).

2/ Incubation period = Time between inoculation and first appearance of curly top symptoms.

TABLE 2. Results of inoculating seedlings of different sugar beet varieties with curly top in the greenhouse.

Test No.	Curly Top Culture No.	Sugar Beet Variety	No. of Plants in Each Curly Top Severity Class[1/]							Total No. of Plants Inoculated	Percent Curly Top	Average Curly Top Rating	Average Incubation Period (days)[2/]
			0	1	2	3	4	5	6				
1	8	U.S. 22/4	15	0	6	2	1	0	0	24	37.4	0.9	16.3
2	7	U.S. 22/4	4	3	2	10	4	0	0	23	82.3	2.3	14.3
		S.L. 742	0	1	0	0	4	10	1	16	100.0	4.6	4.7
3	7	U.S. 22/4	5	1	1	2	11	2	1	23	78.2	3.0	14.0
4	7	U.S. 22/4	4	4	3	2	10	5	0	28	85.7	2.9	15.7
5	7	U.S. 22/4	6	2	1	2	6	3	0	20	70.0	2.4	12.8
		U.S. 75	1	0	0	0	3	9	7	20	95.0	5.4	11.3
		S.L. 742	0	0	0	0	0	0	20	20	100.0	6.0	8.0
6	1-A	U.S. 22/4	5	0	2	3	5	0	0	15	66.7	2.2	15.5
		S.L. 68	3	1	3	1	2	0	0	11	63.6	1.6	22.2
		S.L. 742	2	0	0	0	0	3	11	16	87.0	5.1	9.8
	2-A	U.S. 22/4	8	1	1	2	1	0	1	14	42.8	1.4	19.1
		S.L. 68	2	2	4	2	4	0	0	14	85.8	2.3	19.9
		S.L. 742	0	1	0	0	0	5	10	16	100.0	5.4	11.5

1/ Curly top severity classes range from 0 (no symptoms) to 6 (dead).

2/ Incubation period = time from inoculation to first appearance of curly top symptoms.

FOLIAR FEEDING OF MINERAL NUTRIENTS
1962

By Myron Stout

The beneficial effect of nitrogen deficiency for a period before harvest on the sugar percentage and quality of sugarbeet roots has been well substantiated. However, a practical means of timing nitrogen deficiency in the field is a more difficult problem. The past two years in Cache Valley, Utah, illustrate the uncertainity of estimating nitrogen requirements at the start of the season. More than five inches of precipitation during August, September, and October, 1961, resulted in the lowest sugar percentages for many years. Less than one inch of precipitation for the same period in 1962 resulted in extremely high sugars. Some individual beets tested in 1962 were above 20% sugar and were very low in impurities. Lower soil applications of nitrogen fertilizer before planting would likely reduce the danger of excessive amounts in surface soil and thereby reduce the hazards of late summer or fall rains carrying the surface nitrate to the root zone at the wrong time. However, lower soil applications might result in nitrogen deficiency too early in the season.

The feasibility of foliar feeding of urea to supplement lower soil applications of nitrogen seems attractive, at least from a theoretical standpoint.

Sugarbeet seeds of Variety SL 5070 H3 were planted in quartz sand on June 28th and grown until July 31st with small additions of Hoagland solution. The roots were then washed in distilled water and transplanted to fresh acid-washed quartz sand in pint, conical-shaped, paper, milk cartons. Foliar feeding was started August 20th, after all plants showed severe mineral deficiency symptoms. Three plants per treatment were used except one plant

given distilled water only thereafter. Absorbent cotton was placed around crowns of plants to prevent spray from draining into the sand.

TREATMENT

No.	Roots	Foliage	Plants Dead Dec. 1
1	1/2 Hoagland	none	none
2	1/2 Hoagland (no N)	5% urea	none
3	1/2 Hoagland (no N)	10% urea	none
4	Distilled Water	2 N Hoagland	1
5	" "	2 N Hoagland (N as urea)	3
6	" "	3.5 N Hoagland + 1.43% urea	2

Foliar spray was applied three times weekly until November 15th.

Results

Treatments 2 and 3 produced severe tip burn after repeated applications. Very dark-green foliage. No plants died. Three weeks after last foliar application foliage was growing very rapidly with much darker green color than treatment 1. Treatments 4, 5 and 6 were very evidently deficient in other minerals. Urea apparently was less effective than nitrate under these conditions.

Previous tests at Salt Lake City showed that foliar applications of urea up to 10% concentrations produced only minor leaf injury, provided the applications were infrequent. The present tests indicate that even 5% concentrations can build up toxic concentration if applied frequently. Foliar feeding of supplemental nitrogen as urea offers possibilities as a means to better regulate nitrogen nutrition of the sugar beet under field conditions. Agronomic testing on a small scale seems warranted.

PRELIMINARY TESTS OF SUGAR BEET RESPIRATORY INHIBITORS

By Myron Stout

Ten new chemical herbicides and/or respiratory inhibitors supplied by the Chemical Division of the Pittsburgh Plate Glass Company were tested as possible respiratory inhibitors of sugar beet tissue. Most of the chemicals were very sparingly soluble in water. Those soluble enough were tested on sugar beet root discs at 0.001 molar concentration. Those less soluble were tested at half saturated concentration in water and in 5% ethyl alcohol. The tests were run by means of the Warburg technique at a pH of 4.5 and 6.8.

One chemical (BP2) consistently reduced the respiration rate of sugar beet root discs in all tests. One chemical (BP4) consistently stimulated respiration. The other chemicals had little or no consistent effect on the respiration of root discs at the concentrations used. The 10 chemicals are as follows:

Code	Name	Molecular Formula
IPC	Isopropyl N-Phenylcarbamate	$C_{10}H_{13}O_2$ N
Chloro IPC	Isopropyl N-3-Chlorophenylcarbamate	$C_{10}H_{13}O_2$ N Cl
BP1	Propynyl N-Phenylcarbamate	$C_{10}H_9\ O_2$ N
BP2	Propynyl N-3-Chlorophenylcarbamate	$C_{10}H_8\ O_2$ N Cl
BP3	Alpha-carbo (2,4-Dichlorophenoxy ethoxy) ethyl N-phenylcarbamate	$C_{18}H_{17}O_5$ N Cl_2
BP4	Alpha-carbo (2,4-Dichlorophenoxy ethoxy) ethyl N-3 chlorophenylcarbamate	$C_{18}H_{16}O_5$ N Cl_3
BP7	Isopropyl N-3,4-Dichlorophenylcarbamate	$C_{10}H_{11}O_2$ N Cl_2
BP8	sec-Butyl N-phenylcarbamate	$C_{11}H_{15}O_2$ N
BP9	sec-Butyl N-3 Chlorophenylcarbamate	$C_{11}H_{14}O_2$ N Cl
BP10	sec-Butyl N-3-4-Dichlorophenylcarbamate	$C_{11}H_{13}O_2$ N Cl

WARBURG RESPIRATION TESTS - DECEMBER, 1962

Chemical	Final Molar Concentration	ul O_2 per gm dry wt. per hr. Test 2	Test 3	Test 4	Test 5
Check	H_2O	243	222	223	211
IPC	.001	264m	216	222	190
Chloro IPC	.001	249	203	207	197
BP 1	.001	269	202	212	178
BP 2	1/2 sat.1/	197	163	139	171
BP 3	1/2 sat.	274	235	242	219
BP 4	1/2 sat.	254	257	277	224
BP 7	1/2 sat.	248	220	247	195
BP 8	1/2 sat.	249	222	249	202
BP 9	.001	225	219	176	166
BP 10	1/2 sat.	249	211	205	186
pH		6.8	4.5	6.8	4.5

1/ Chemicals in tests 2 and 3 were made up to 0.002 molar concentration, heated in an oven overnight at 65° to 70° C. and shaken frequently then cooled, before making to final volume. Chemicals in tests 4 and 5 were dissolved in 5 ml. alcohol then diluted to 100 ml. with water, allowed to settle at room temperature for two days, then tested. One-half saturated concentration refers to 1 to 1 dilution of the saturated solution with sucrose-Kcl-buffer in the Warburg flask.

PART IV

EVALUATION OF BASIC BREEDING MATERIAL AND VARIETIES OF SUGARBEETS SUITABLE FOR THE GREAT LAKES REGION

Foundation Project 26

G. E. Coe
Dewey Stewart

H. W. Bockstahler
G. J. Hogaboam

Cooperators conducting field tests:

Farmers & Manufacturers Beet Sugar Association
Buckeye Sugars, Inc.
Canada and Dominion Sugar Company, Ltd.
Michigan Sugar Company
Monitor Sugar Division
Northern Ohio Sugar Company
Michigan Agricultural Experiment Station
Wisconsin Agricultural Experiment Station
Western Ontario Agricultural School, Ridgetown, Ontario

EVALUATION OF BASIC BREEDING MATERIAL AND VARIETIES SUITABLE FOR THE GREAT LAKES REGION

Dewey Stewart

The cooperative variety trials of 1962 in the Great Lakes region were conducted primarily to evaluate synthetic varieties and hybrids for regional adaptation. The field tests reported in this Part of the Report include also exploratory evaluations of breeder seed and experimental hybrids which have been developed for the most part in breeding research at the Plant Industry Station, Beltsville, and at East Lansing, Michigan, in cooperation with the Michigan Agricultural Experiment Station.

The seven uniform variety trials conducted by the Farmers and Manufacturers Beet Sugar Association and company members are summarized on page 99. The individual field tests are given on pages 100 through 113. Introductory trials of new developments in breeding research are reported on pages 114-123.

The USDA entries in field trials conducted by the Northern Ohio Sugar Company are given on pages 128-138. In addition, variety tests were conducted by the Hancock Substation, Wisconsin Agricultural Experiment Station and by the Western Ontario Agricultural School, Ridgetown, Ontario.

The occurrence of moderate to severe leaf spot, in 9 of 16 cooperative tests, indicates that 1962 was a favorable year for the disease in the Great Lakes region. Black root was moderately severe in 5 fields. Special note was made of severe losses from Rhizoctonia root rot in three tests.

SP 5481-0 is the only multigerm variety in the uniform trials summarized on page 99. The 7 other entries are monogerm. They may be appraised with respect to the various attributes by reference to the performance of SP 5481-0. The monogerm hybrid SL 122 MS X SP 5460-0, which is widely used in the Great Lakes region, did not differ significantly from SP 5481-0 in any of the attributes. This was also true for the other monogerm varieties except root yield of SP 6162-0. These results demonstrate that progress is being made in the development of monogerm varieties that may be used as a replacement for the multigerm variety SP 5481-0 or US 401. Nevertheless, further improvement of monogerm sorts with respect to disease resistance is urgently needed and there is a continuing demand for enhancement in root yield and quality.

Attention is directed to the excellent performance of the multigerm variety SP 5822-0 in tests conducted by the Northern Ohio Sugar Company. In tests reported on pages 129, 131, and 135, the leaf spot resistance, root yield, and sucrose percentage of SP 5822-0 were above the general mean of the respective test, and in 2 of the 3 tests the thin juice apparent purity of SP 5822-0 was significantly above that of all other entries. SP 6122-0 and SP 61151-0 which are selections by G. E. Coe from SP 5822-0, show the parental tendency for high thin juice purity.

Three monogerm triploid hybrids, which were produced by using the tetraploid US 401 of Helen Savitsky as pollinators, were outstanding in root yield in the exploratory tests summarized on page 118. The root yield of the monogerm triploid SLC 129 MS X US 401 (4n) was significantly higher than that of SP 5481-0, the multigerm check.

DESCRIPTION OF ENTRIES IN FIELD TRIALS OF 1962

Leaf Spot Readings at Beltsville, Maryland

Entry No.	Description	Leaf Spot[1/] (1)	Leaf Spot[1/] (2)
SP 6161-0	- Monogerm synthetic from interpollination of 6 clones. Yield selection	3.0	3.5
SP 6162-0	- Monogerm synthetic from interpollination of 6 clones. Sugar selection	3.0	3.3
SP 61624-0	- Monogerm variety. From backcross progenies	3.7	3.7
F60-561HO MS mm	X SP 5460-0 MM - F60-561HO is a monogerm male-sterile line developed by J. S. McFarlane	3.7	5.0
F59-569HO MS mm	X SP 5460-0 MM - F59-569HO is a monogerm male-sterile line developed by J. S. McFarlane	4.3	5.0
(A1-10 X A1-12	X SP 5460-0 MM - (A1-10 X A1-12) is a monogerm male-sterile from Amalgamated Sugar Company.	4.7	5.2
SL 122 MS mm X SP 5460-0 MM.	Commercial monogerm hybrid	4.7	4.8
SP 5481-0	- Multigerm variety. Resistance to leaf spot and black root.	3.7	4.5
SP 60194-01)	- Monogerm varieties obtained from backcross progenies	3.3	3.5
SP 60195-01)		2.7	3.3
SP 61AB21-0	- Monogerm variety: sugar selection.	3.7	4.0
SP 61B22-0	- Monogerm variety: high purity selection.	2.7	3.5
SP 61B23-0	- Monogerm variety: selection from SP 60B1-0 (SP 5832-0)	3.0	3.5
SP 61B24-0	- Monogerm variety; selection from SP 5931-0	3.3	4.0
SP 5822-0	- Multigerm synthetic variety. From interpollination of 8 leaf spot resistant clones	2.3	2.8
SP 6122-0	- Multigerm variety; selection from SP 5822-0.	2.3	2.8
SP 61151-0	- Multigerm variety; selection from SP 5822-0	-	-
SP 6180-0	- Multigerm synthetic. Interpollination of selfed progenies of 6 plants whose polycross progeny was good.	-	3.5

1/ Leaf spot readings, Beltsville, Md. Column 1 = late planting; column 2 = early planting.
Scale of damage: 0 = no damage; 10 = total loss of foliage.

Entry No.	Description	Leaf Spot (1)	Leaf Spot (2)
EL 61B18-0	- Multigerm. Increase of SP 59B18-0, which was produced by crossing clone 02 00 00 MM self-sterile X 7 clones derived from US 401.	-	-
SL 122 MS	- Monogerm line resistant to curly top	-	-
SL 126 MS	- Monogerm line resistant to curly top	-	-
SL 128 MS	- Monogerm line resistant to curly top	-	-
SL 129 MS	- Male-sterile monogerm line.	-	-
(122 X 127 X 129)	- Monogerm and male-sterile.	-	-
US 401 4n	- Multigerm US 401 tetraploidized by Helen Savitsky	-	4.5
1539H1	- (Male-sterile of 515 X 569) X NB 7.	5.0	6.0
SP 60300-0	- Monogerm variety. From a pooling of polycross seed.	3.7	-
SP 601000-0	- Self-sterile monogerm variety from J. O. Gaskill. Resistant to leaf spot and black root. One selection for storage rot (Botrytis) resistance.	3.7	4.5
SP 61602-01)		-	4.0
SP 61605-01)		-	4.7
SP 61606-01)		-	4.3
SP 61607-01)		-	4.0
SP 61613-01)	- Monogerm: From backcross progenies	-	4.3
SP 61618-01)		3.0	-
SP 61622-01)		-	4.7
SP 61623-01)		-	4.3
SP 61627-01)		-	3.7
SP 61628-01)		3.0	-
SP 5460-0	- Multigerm. From interpollination of plants selected from progeny outstanding in leaf spot resistance.	-	3.5
SP 603103-01	- Tetraploid multigerm. From selfed progeny of one parent plant of SP 5460-0.	-	3.7
02 00 00 clone	- Multigerm: resistant to leaf spot and black root.	3.0	-

Entry No.		Description	Leaf Spot (1)	Leaf Spot (2)
SL 126 X SP 5460-0			4.0	5.0
SL 129 X SP 5460-0			-	3.8
SL 128 X SP 5460-0			4.7	-
SL 128 X SP 5822-0			3.7	-
SL 128 X US 401 (4n)			4.7	5.0
SL 129 X US 401 (4n)			5.0	-
Acc. 2269	-	Susceptible check	5.5	6.0
62B1 X 02	-	SL 122 X 02 00 00 clone	-	-
62B2 X 02	-	SL 122 X SP 5822-0	3.3	-
62B3 X 02	-	SL 122 X SP 5460-0	4.7	-
62B4 X 02	-	SL 122 X SP 603103-01 (4n)	3.0	-
62B1 X 03	-	SL 126 X 02 00 00 clone	3.7	-
62B2 X 03	-	SL 126 X SP 5822-0	3.7	-
62B3 X 03	-	SL 126 X SP 5460-0	4.3	-
62B4 X 03	-	SL 126 X SP 603103-01 (4n)	3.0	-
62B1 X 04	-	AI-12 X 02 00 00 clone	4.3	-
62B2 X 04	-	AI-12 X SP 5822-0	4.0	-
62B3 X 04	-	AI-12 X SP 5460-0	4.0	-
62B4 X 04	-	AI-12 X SP 603103-01 (4n)	3.0	-
62B1 X 05	-	EL 32 C_1 X 02 00 00 clone	4.7	-
62B2 X 05	-	EL 32 C_1 X SP 5822-0	3.0	-
62B3 X 05	-	EL 32 C_1 X SP 5460-0	3.7	-
62B1 X 06	-	EL 33 C_1 X 02 00 00 clone	4.3	-
62B2 X 06	-	EL 33 C_1 X SP 5822-0	3.3	-
62B3 X 06	-	EL 33 C_1 X SP 5460-0	3.0	-
62B1 X 07	-	EL 34 C_1 X 02 00 00 clone	4.7	-
62B2 X 07	-	EL 34 C_1 X SP 5822-0	3.3	-
62B3 X 07	-	EL 34 C_1 X SP 5460-0	-	-
62B4 X 07	-	EL 34 C_1 X SP 603103-01 (4n)	3.0	-
62B1 X 08	-	SP 6121-01 X 02 00 00 clone	-	-
62B4 X 08	-	SP 6121-01 X SP 603103-01 (4n)	3.0	-
62B1 X 09	-	SP 6123-01 X 02 00 00 clone	3.7	-
62B2 X 09	-	SP 6123-01 X SP 5822-0	2.7	-
62B3 X 09	-	SP 6123-01 X SP 5460-0	3.3	-
62B4 X 09	-	SP 6123-01 X SP 603103-01 (4n)	3.0	-
62B1 X 010	-	SP 6124-01 X 02 00 00 clone	3.3	-
62B2 X 010	-	SP 6124-01 X SP 5822-0	3.7	-
62B4 X 010	-	SP 6124-01 X SP 603103-01 (4n)	2.7	-
EL 32 C_1)			-	-
EL 33 C_1)			-	-
EL 34 C_1)			-	-
SP 6121-01)	-	Monogerm. Cytoplasmic male-sterile lines.	-	-
SP 6123-01)			-	-
SP 6124-01)			-	-

Summary of 7 Varietal Tests Conducted in 1962 by F & M Beet Sugar Association and Company Members

The tests included in the summary are Sebewaing (p.100), Saginaw (p.102), Essexville (p.104), and Croswell(p.106), Michigan; Pandora (p.108) and Hamler (p.110), Ohio; and Wallaceburg (p.112), Ontario.

Variety and Description	Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Purity	Beets per 100' of row
	Pounds	Tons	Percent	Percent	Number
SP 6161-0	6610 7	20.91 5	15.70 8	83.56 1	92
SP 6162-0	6261 8	19.33 8	16.08 4	83.27 5	93
SP 61624-0	6882 2	21.57 2	15.83 6	83.14 6	94
F 60-561 HO X SP 5460-0	6803 4	21.36 3	15.80 7	82.00 8	85
F 59-569 HO X SP 5460-0	7095 1	21.89 1	16.10 3	82.95 7	90
(AI-10 X AI-12) X SP 5460-0	6819 3	20.85 6	16.31 1	83.39 2	95
SL 122 MS X SP 5460-0	6732 6	20.66 7	16.18 2	83.38 4	94
SP 5481-0	6787 5	21.06 4	15.99 5	83.38 4	85
General Mean	6.749	20.95	16.00	83.13	91
S.E. Var. Mean	188.9	.4779	.1178	.5247	3.0
S.E. Var. Mean as % Gen.Mean	2.80	2.28	0.74	0.63	3.30
Diff. for Sig. (odds 19:1)	NS	1.36	0.34	NS	NS

Latin Square Analysis — Variance Table

Source of Variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between Locations	6	25,451,785	189.8615	17.2434	58.9052	1790
Between varieties	7	404,746	4.1944	.3377	1.5412	107
Remainder - Error	42	249,809	1.5985	.0972	1.9273	65
Total	55					
Calculated F. value	7/42	NS	2.62*	3.48**	NS	NS

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Harold Gremel farm, Sebewaing, Michigan

Cooperation: F & M Beet Sugar Association, Michigan Sugar Company

Date of Planting: April 17, 1962

Date of Harvest: October 27, 1962

Experimental Design: 8 X 8 Latin Square

Size of Plots: 6 rows X 28 feet - 28" rows

Harvested Area per plot for Root Yield: 4 rows X 26'

Samples for Sucrose Determination: 2 samples of 10 beets each taken consecutively from the outside harvested rows.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: 1959 - Pasture and Hay
1960 - Corn 300# 6-24-12
1961 - Beans 300# 6-24-12 + manganese

Fertilization of Beet Crop: 700# 6-24-12 with manganese and Boron banded at planting time.

Black Root Exposure: Slight

Leaf Spot Exposure: Moderate

Other Diseases and Pests: None

Soil and Seasonal Conditions: Moist seedbed - Generally good growing conditions throughout the growing season.

Reliability of Test: Good

Cooperator: F.&M. Beet Sugar Association, Michigan Sugar Co. Year: 1962

Location: Harold Gremel farm, Sebewaing, Michigan Expt: 1

8 x 8 Latin Square

(Results given as 8 plot averages)

Variety and Description	Acre-Yield Gross Sugar Pounds	Acre-Yield Roots Tons	Sucrose Percent	Purity Percent	Beets per 100' of row Number
SP 6161-0	7722 5	23.70 4	16.38 8	84.38 7	102
SP 6162-0	7090 8	21.13 8	16.79 2	84.60 6	100
SP 61624-0	7950 2	23.83 2	16.70 5	83.99 8	100
F 60-561 HO X SP 5460-0	7840 3	23.77 3	16.49 7	85.21 2	95
F 59-569 HO X SP 5460-0	7779 4	23.30 5	16.71 4	85.09 3	101
(AI-IO X AI-12) X SP 5460-0	7538 6	22.52 6	16.78 3	85.22 1	103
SL 122 MS X SP 5460-0	7423 7	22.42 7	16.57 6	84.91 4	99
SP 5481-0	8266 1	24.48 1	16.89 1	84.86 5	103
General Mean	7701	23.14	16.66	84.78	100
S.E. Var. Mean	156	.4816	.2296	.8758	2.94
S.E. Var. Mean as % Gen. Mean	2.03	2.08	1.38	1.03	2.94
Diff. for Sig. (odds 19:1)	445	1.37	NS	NS	NS

Latin Square Analysis — Variance Table

Source of Variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between rows	7	764,039	6.5639	.7849	4.1756	185
Between columns	7	422,380	10.2346	1.1991	8.3276	44
Between varieties	7	1,010,407	9.0731	.2517	1.7900	56
Remainder - Error	42	194,939	1.8560	.4220	6.1371	69
Total	63					
Calculated F. value	7/42	5.18**	4.89**	NS	NS	NS

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Leonard Eckstorm

Cooperation: F & M Beet Sugar Association, Monitor Sugar Division

Date of Planting: April 27, 1962

Date of Harvest: October 17, 1962

Experimental Design: 8 X 8 Latin Square

Size of Plots: 6 rows X 28 feet - 28" between rows

Harvested Area per plot for Root Yield: 4 rows X 26'

Samples for Sucrose Determination: 2 samples of 10 beets each taken consecutivel
from the outside harvested rows.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: 1959 - Bean 150# 10-10-10 - Rye plowed down;
1960 - Beans Liquid Nitrogen (45%) plowed down;
1961 - Beans 200# 10-10-10

Fertilization of Beet Crop: 400# 6-24-12 + Manganese

Black Root Exposure: Moderate

Leaf Spot Exposure: Moderate

Other Diseases and Pests: Test was hit hard with black aphids in late July.

Soil and Seasonal Conditions: Moist seedbed. Generally good growing conditions.

Reliability of Test: Fair

Cooperator: F.& M. Beet Sugar Association, Monitor Sugar Div. Year: 1962

Location: Leonard Eckstorm farm, Saginaw, Mich. Expt. 4

8 X 8 Latin Square

(Results given as 8 plot averages)

Variety and Description	Acre-Yield Gross Sugar Pounds	Acre-Yield Roots Tons	Sucrose Percent	Purity Percent	Beets per 100' of row Number
SP 6161-0	5333 8	15.28 8	17.41 8	84.82 8	105
SP 6162-0	5580 7	15.54 7	17.96 4	85.27 6	105
SP 61624-0	5781 4	16.28 4	17.74 6	85.82 3	102
F 60-561 HO X SP 5460-0	5845 2	16.70 1	17.50 7	85.43 5	102
F 59-569 HO X SP 5460-0	5784 3	16.28 4	17.77 5	86.06 2	90
(AI-10 X AI-12) X SP 5460-0	5635 6	15.56 6	18.11 2	85.72 4	106
SL 122 MS X SP 5460-0	5763 5	15.87 5	18.16 1	85.18 7	103
SP 5481-0	5971 1	16.61 2	17.98 3	86.08 1	97

General Mean	5711	16.01	17.83	85.55	101
S.E. Var. Mean	181.7	.4759	.2021	.6819	2.9
S.E. Var. Mean as % Gen. Mean	3.18	2.97	1.13	0.80	2.84
Diff. for Sig. (odds 19:1)	NS	NS	NS	NS	8

Latin Square Analysis — Variance Table

Source of Variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between rows	7	525,897	3.3754	.2540	4.4147	28
Between columns	7	822,432	6.7728	.2129	2.9654	107
Between varieties	7	302,018	2.3067	.6836	1.4051	216
Remainder - Error	42	263,980	1.8118	.3269	3.7201	66
Total	63					
Calculated F. value	7/42	NS	NS	NS	NS	3.28**

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Victor Beslaer farm, Essexville, Michigan

Cooperation: F & M Beet Sugar Association, Monitor Sugar Division

Date of Planting: April 25, 1962

Date of Harvest: October 15, 1962

Experimental Design: 8 X 8 Latin Square

Size of Plots: 6 rows X 28 feet, 28" between rows

Harvested Area per plot for Root Yield: 4 rows X 26'

Samples for Sucrose Determination: 2 samples of 10 beets each taken consecutively from the outside harvested rows.

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1959 Potatoes 1100# 4-16-16
1960 Wheat 400# 4-16-16
1961 Beans 350# 4-16-16

Fertilization of Beet Crop: 300# 10-10-10 broadcast
600# 3-12-12 banded at planting time
300# 10-10-10 sidedressed

Black Root Exposure: None

Leaf Spot Exposure: Slight

Other Diseases and Pests: None

Soil and Seasonal Conditions: Moist seedbed. Generally good growing conditions throughout season except period of dry weather in September.

Reliability of Test: Excellent

Cooperator: F.& M. Beet Sugar Association, Monitor Sugar Div. Year: 1962

Location: Victor Beslaer farm, Essexville, Mich. Expt: 3

S X 8 Latin Square

(Results given as 8 plot averages)

Variety and Description	Acre-Yield Gross Sugar Pounds	Acre-Yield Roots Tons	Sucrose Percent	Purity Percent	Beets per 100' of row Number
SP 6161-0	7031 7	22.80 5	15.43 8	81.66 8	106
SP 6162-0	6732 8	20.73 8	16.25 3	83.36 3	104
SP 61624-0	7304 4	23.21 3	15.71 7	83.83 2	109
F 60-561 HO X SP 5460-0	7872 1	24.34 1	16.21 5	82.71 5	110
F 59-569 HO X SP 5460-0	7610 3	23.79 2	16.00 6	81.84 7	107
(AI-10 X AI-12) X SP 5460-0	7120 6	22.00 7	16.22 4	82.18 6	113
SL 122 MX X SP 5460-0	7205 5	21.78 6	16.55 1	84.26 1	108
SP 5481-0	7620 2	23.22 4	16.41 2	82.72 4	106
General Mean	7312	22.73	16.10	82.82	108
S.E. Var. Mean	191.1	.3883	.2892	.9664	2.5
S.E. Var. Mean as % Gen. Mean	2.61	1.71	1.80	1.17	2.36
Diff. for Sig. (odds 19:1)	875	1.11	NS	NS	NS

Latin Square Analysis — Variance Table

Source of Variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between rows	7	616,926	7.3698	3.5859	8.7498	172
Between columns	7	407,525	1.8053	1.2244	6.4022	81
Between varieties	7	1,098,011	10.9778	1.1472	7.3972	64
Remainder - Error	42	292,061	1.2064	.6691	7.4721	52
Total	63					
Calculated F. value	7/42	3.76**	9.10**	NS	NS	NS

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Reed Gordon farm, Croswell, Michigan

Cooperation: F & M Beet Sugar Association, Michigan Sugar Company

Date of Planting: May 10, 1962

Date of Harvest: November 3, 1962

Experimental Design: 8 X 8 Latin Square

Size of Plots: 6 rows X 28 feet - 28" between rows.

Harvested Area per plot for Root Yield: 4 rows X 26'

Samples for Sucrose Determination: 2 samples of 10 beets each taken consecutively from the outside harvested rows.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: 1959 - Oats - 250# 6-24-12
1960 - Sod
1961 - Sod - 10 tons manure/acre

Fertilization of Beet Crop: 600# 6-24-12 banded at planting

Black Root Exposure: Moderate

Leaf Spot Exposure: None

Other Diseases and Pests: None

Soil and Seasonal Conditions: Moist seedbed - Excessive moisture (over 7'') in seedling stage. Good growing conditions during balance of season.

Reliability of test: Fair

Cooperator: F.& M. Beet Sugar Association, Michigan Sugar Co. Year: 1962

Location: Reed Gordon farm, Croswell, Michigan Expt: 2

8 X 8 Latin Square

(Results given as 8 plot averages)

Variety and Description	Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Purity	Beets per 100' of row
	Pounds	Tons	Percent	Percent	Number
SP 6161-0	4766 7	16.20 6	14.71 8	84.48 1	87
SP 6162-0	4719 8	15.41 8	15.24 4	82.51 6	84
SP 61624-0	5130 5	17.05 5	15.07 6	82.27 7	89
F 60-561 HO X SP 5460-0	5384 3	17.47 3	15.38 2	83.49 3	82
F 59-569 HO X SP 5460-0	5442 2	17.77 2	15.33 3	81.89 8	87
(AI-IO X AI-12) X SP 5460-0	5608 1	17.85 1	15.73 1	83.74 2	94
SL 122 MS X SP 5460-0	4772 6	15.69 7	15.19 5	83.13 4	77
SP 5481-0	5179 4	17.19 4	15.06 7	82.79 5	80
General Mean	5125	16.83	15.21	83.04	85
S.E. Var. Mean	164.6	.4797	.2129	.8251	3.1
S.E. Var. Mean as % Gen. Mean	3.21	2.85	1.40	0.99	3.65
Diff. for Sig. (odds 19:1)	469	1.37	NS	NS	9

Latin Square Analysis		Variance Table				
		Mean Squares				
Source of Variation	D/F	Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between rows	7	588,410	6.0623	.4045	4.8002	24
Between columns	7	1,134,255	11.3291	.3466	4.9422	79
Between varieties	7	939,496	7.1086	.6463	6.0469	244
Remainder - Error	42	216,641	1.8409	.3625	5.4469	75
Total	63					
Calculated F. value	7/42	4.34**	3.86**	NS	NS	3.24**

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Louis Risser Jr. farm, Pandora, Ohio

Cooperation: F & M Beet Sugar Association, Buckeye Sugars Inc.

Date of Planting: April 11, 1962

Date of Harvest: October 23, 1962

Experimental Design: 8 X 8 Latin Square

Size of Plots: 6 rows X 28 ft., 28'' between rows.

Harvested Area per plot for Root Yield: 4 rows X 26'

Samples for Sucrose Determination: 2 samples of 10 beets each taken consecutively from the outside harvested rows.

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1959 Corn 300# 53-18-6
1960 Corn 325# 53-18-6
1961 Corn 325# 53-18-6

Fertilization of Beet Crop: 2 tons of beet plant lime and 350# of 62% K 62# N (Urea) plowed down; 350# 8-24-0 and 20# polybor and banded at planting time; 56# N sidedressed.

Black Root Exposure: Slight

Leaf Spot Exposure: Moderate

Other Diseases and Pests: Rhezoctonia crown rot

Soil and Seasonal Conditions: Moist seedbed - Moisture lacking throughout most of summer.

Reliability of Test: Fair

Cooperator: F & M Beet Sugar Association, Buckeye Sugars, Inc. Year: 1962

Location: Louis Risser Jr., farm, Pandora, Ohio Expt: 6

8 X 8 Latin Square

(Results given as 8 plot averages)

Variety and Description	Acre-Yield Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
	Pounds	Tons	Percent	Percent	Number
SP 6161-0	4065 5	14.88 7	13.48 4	80.78 1	70
SP 6162-0	3699 8	13.22 8	13.78 2	79.53 2	70
SP 61624-0	3843 7	15.12 5	12.69 8	76.87 7	66
F 60-561 HO X SP 5460-0	3945 6	14.97 6	13.04 7	70.21 8	66
F 59-569 HO X SP 5460-0	4243 3	16.06 2	13.21 5	77.00 6	65
(AI-10 X AI-12) X SP 5460-0	4608 1	16.43 1	14.02 1	78.71 4	83
SL 122 MS X SP 5460-0	4198 4	15.41 4	13.58 3	78.74 3	74
SP 5481-0	4257 2	16.00 3	13.18 6	78.21 5	63
General Mean	4107	15.26	13.37	77.50	70
S.E. Var. Mean	232.5	.8137	.2556	3.190	2.9
S.E. Var. Mean as % Gen.Mean	5.66	5.33	1.91	4.12	4.20
Diff. for Sig. (odds 19:1)	NS	NS	NS	NS	8

Latin Square Analysis — Variance Table

Source of Variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between rows	7	2,754,219	25.0894	2.4280	79.6515	12
Between columns	7	1,573,688	15.5242	1.1715	133.3072	410
Between varieties	7	644,509	7.9557	1.4354	82.8282	339
Remainder - Error	42	432,622	5.2971	.5227	81.3971	69
Total	63					
Calculated F. value	7/42	NS	NS	2.75*	NS	4.91

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Arthur Busch farm, Hamler, Ohio

Cooperation: F & M Beet Sugar Association

Date of Planting: April 12, 1962

Date of Harvest: October 24, 1962

Experimental Design: 8 X 8 Latin Square

Size of Plots: 6 rows X 28' 28" apart

Harvested Area per plot for Root Yield: 4 rows X 26 feet

Samples for Sucrose Determinations: 2 samples of 10 consecutive beets each from the outside harvested rows.

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1959 - Tomatoes - 800# 6-24-12
1960 - Beets - 600# 6-24-12, 100# N, 2 ton lime
1961 - Corn - 250# 6-24-12, 70# N

Fertilization of Beet Crop: 825# 6-24-12

Black Root Exposure: Nil

Leaf Spot Exposure: Slight

Other Diseases and Pests: None

Soil and Seasonal Conditions: Good throughout season

Reliability of test: Excellent

Cooperator: F.& M. Beet Sugar Association, Buckeye Sugars,Inc. Year: 1962

Location: Arthur Busch farm, Hamler, Ohio Expt. 7

8 X 8 Latin Square

(Results given as 8 plot averages)

Variety and Description	Acre-Yield Gross Sugar Pounds	Roots Tons	Sucrose Percent	Purity Percent	Beets per 100' of row Number
SP 6161-0	8803 (6)	25.59 (6)	17.22 (5)	85.25 (4)	98
SP 6162-0	6737 (8)	20.33 (8)	16.51 (8)	84.37 (7)	98
SP 61624-0	8684 (7)	25.35 (7)	17.16 (6)	86.04 (1)	100
F 60-561 HO X SP 5460-0	9037 (3)	27.06 (1)	16.71 (7)	84.95 (5)	92
F 59-569 HO X SP 5460-0	9227 (1)	26.23 (2)	17.58 (2)	85.81 (2)	96
(AI-10 X AI-12) X SP 5460-0	9102 (2)	25.86 (3)	17.58 (2)	84.80 (6)	106
SL 122 MS X SP 5460-0	8936 (5)	25.78 (4)	17.26 (4)	84.06 (8)	103
SP 5481-0	9025 (4)	25.71 (5)	17.56 (3)	85.63 (3)	100
General Mean	8694	25.24	17.20	85.11	99
S.E. Var. Mean	297.4	.7671	.2558	.9787	2.1
S.E. Var. Mean as % Gen. Mean	3.42	3.04	1.49	1.15	2.07
Diff. for Sig. (odds 19:1)	848	2.19	0.73	NS	6

Latin Square Analysis — Variance Table

Source of Variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between rows	7	1,163,871	3.9015	2.0784	16.3765	43
Between columns	7	2,704,579	19.3187	1.0936	1.1695	63
Between varieties	7	5,232,619	33.6802	1.3343	3.8098	151
Remainder - Error	42	707,427	4.7071	.5236	7.6635	34
Total	63					
Calculated F. value	7/42	7.40**	7.16**	2.55*	NS	4.44**

AGRONOMIC EVALUATION TEST

Conducted by : C. E. Broadwell

Location : C & D Sugar Co.Ltd., Wallaceburg Experimental farm

Cooperation : Canada & Dominion Sugar Co.,Ltd.

Date of Planting : April 11, 1962

Date of Harvest : October 6, 1962

Experimental Design : 8 x 8 Latin Square. Design # 8.

Size of Plots : 6 rows x 28'.24 "between rows.

Harvested Area per plot for Root Yield : 4 rows x 28'.

Samples for Sucrose Determination : 2 samples of 10 beets each, selected at random.

Stand Counts : Harvested beets counted when weighed

Recent Field History : Oats

Fertilization of Beet Crop : 600 # 5-20-20 banded below seed

Blackroot Exposure : None

Leaf Spot Exposure : Moderate

Other Diseases & Pests : Flea beetles

Soil and Seasonal Conditions : Excellent shape when planted. Fairly good moisture throughout year

Reliability of Test : Good

Cooperator: C.& D.Sugar Co.Ltd.,F.&M.Beet Sugar Association Year:1962

Location: C.& D. Wallaceburg Experimental Farm, Wallaceburg, Ontario Expt: 8

8 X 8 Latin Square

(Results given as 8 plot averages)

Variety and Description	Acre-Yield Gross Sugar Pounds	Acre-Yield Roots Tons	Sucrose Percent	Purity Percent	Beets per 100' of row Number
SP 6161-0	8550 5	27.90 4	15.31 6		72
SP 6162-0	9266 3	28.98 3	16.00 2		89
SP 61624-0	9485 2	30.15 1	15.73 5		89
F 60-561 HO X SP 5460-0	7699 7	25.21 7	15.25 7		52
F 59-569 HO X SP 5460-0	9577 1	29.77 2	16.09 1		86
(AI-10 X AI-12) X SP 5460-0	8123 6	25.76 6	15.76 4		60
SL 122 MS X SP 5460-0	8829 4	27.65 5	15.98 3		93
SP 5481-0	7194 8	24.19 8	14.86 8		43
General Mean	8590	27.45	15.62		73
S.E. Var. Mean	229.4	.7276	.1167		2.7
S.E. Var. Mean as % Gen. Mean	2.67	2.65	0.75		3;67
Diff. for Sig. (odds 19:1)	654	2.08	0.33		8

Latin Square Analysis — Variance Table

Source of Variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between rows	7	523,114	4.9368	0.2714		32
Between columns	7	1,282,255	9.4765	0.2858		220
Between varieties	7	6,001,727	38.5838	1.6044		2903
Remainder - Error	42	420,840	4.2355	0.1089		57
Total	63					
Calculated F. value	7/42	14.26**	9.11**	14.74**		50.52**

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Frank Metzger Farm, Fort Jennings, Ohio

Cooperation: F & M Beet Sugar Association

Date of Planting: May 4, 1962

Date of Harvest: October 30, 1962

Experimental Design: 5 X 6 Rectangular Lattice, Design 1

Size of Plots: 4 rows X 20 feet. 36" between rows

Harvested Area per plot for Root Yield: 4 rows X 18'

Samples for Sucrose Determinations: 2 samples of 10 consecutive beets each from the outside harvested rows.

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1959 - Beets - 300# 0-0-60, 125# 11-48-0, 80#N
1960 - Corn - 150# 0-0-60, 100# 11-48-0, 80#N
1961 - Tomatoes - 500# 0-0-60, 60#N

Fertilization of Beet Crop: 400# 0-0-60, 100# 18-46-0, 90#N

Black Root Exposure: Rhizoc hit early, reducing stand.

Leaf Spot Exposure: Light to moderate

Other Diseases and Pests: Yield and stand adjusted by harvested feet of row due to Rhizoc.

Soil and Seasonal Conditions: Generally good all season

Reliability of test: Fair

Cooperator: F. & M.Beet Sugar Association, Buckeye Sugars,Inc. Year: 1962

Location: Frank Metzger farm. Fort Jennings, Ohio Expt: 11

5 X 6 Rectangular Lattice Design - 6 repl. - Analyzed as Randomized Block

(Results given as 6 plot averages)

Variety and Description		Acre-Yield Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
		Pounds	Tons	Percent	Percent	Number
61B24-0	1	7025 13	21.52 11	16.43	84.00 9	95
61B23-0	2	6170	18.41	16.78	80.69	93
61B22-0	3	6944	20.36 17	17.06 15	84.18 8	100
61AB21-0	4	6738	20.26 18	16.62	83.11 21	96
129ms X US 401(4N)		8343 1	24.43 1	17.09 13	83.54 17	95
126ms X SP 5460-0		7600 7	22.06 8	17.19 8	83.61 16	96
(122X127) X 129 X US 401(4N)		7954 3	23.72 3	16.76	83.84 12	98
(122X128) X 126ms X 5460-0		7439 9	22.09 7	16.82	83.91 11	98
128ms X SP5460-0	9	7928 4	22.98 4	17.23 6	84.44 6	97
128ms X US 401(4N)	10	7876 5	24.06 2	16.39	82.77	94
128ms X 5822-0	11	8061 2	22.85 5	17.69 1	84.60 4	104
SP 61602-01	12	6192	18.82	16.53	82.21	91
SP 61605-01	13	6775	19.71	17.18 10	83.92 10	99
SP 61606-01	14	6845	19.69	17.43 4	84.93 2	104
SP 61607-01	15	6934	20.21 19	17.21 7	83.81 13	99
SP 61613-01	16	7103	20.85 13	17.07 14	84.32 7	107
SP 61618-01	17	6336	18.48	17.13 11	83.32 19	99
SP 61622-01	18	7384 10	21.81 9	16.88	82.98	104
SP 61623-01	19	6643	19.35	17.18 10	83.69 15	104
SP 61627-01	20	6876	20.75 14	16.60	81.53	101
SP 61628-01	21	6675	19.62	16.99	83.25 20	106
SP 60194-01	22	6740	19.86	16.97	82.40	97
SP 60195-01	23	6189	18.72	16.46	83.77 14	100
SP 60196-01	24	7289 11	20.93 12	17.43 4	84.89 3	114
1539H1	25	6019	19.30	15.52	81.98	96
SP 601000-0	26	6146	18.36	16.71	82.84	96
SP 60300-0	27	6660	20.65 15	16.09	82.80	97
122 X 128 X 126 X SP5822-0	28	7870 6	22.46 6	17.54 2	84.50 5	106
122 X SP 5460-0	29	7104 12	20.41 16	17.41 5	83.37 18	94
SP 5481-0	30	7443 8	21.74 10	17.12 12	84.98 1	104
General Mean		7043	20.81	16.92	83.47	99
S.E. Var. Mean		257.3	.7127	.3728	1.129	4.1
S.E. Var. Mean as % Gen.Mean		3.65	3.42	2.20	1.35	4.12
Diff. for Sig. (odds 19:1)		720	1.99	NS	NS	NS

Random Block Analysis — Variance Table

Source of Variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between replications	5	4,527,198	25.6237	2.4896	41.9913	407
Between varieties	29	2,458,411	17.5757	1.2632	6.4187	154
Remainder - Error	145	397,325	3.0487	0.8339	7.6448	100
Total	179					
Calculated F. value	29/145	6.19**	5.77**	NS	NS	NS

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Detroit Stake Farm, Merrill, Michigan

Cooperation: Farmers & Mfgrs. Beet Sugar Association, Michigan Sugar Company

Date of Planting: April 30, 1962

Date of Harvest: October 5, 1962

Experimental Design: 5 X 6 Rectangular Lattice

Size of Plots: 6 rows X 20 feet long - 32" between rows.

Harvested Area per plot for Root Yield: 6 rows X 18 feet

Samples for Sucrose Determination: Two samples of 10 consecutive beets each from the outside harvested rows.

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1959 - Corn,
1960 - Corn 400# 10-20-10 + Manure,
1961 - Fallow

Fertilization of Beet Crop: 500# 10-20-10 banded at planting time.

Black Root Exposure: Slight

Leaf Spot Exposure: Slight

Other Diseases and Pests: None

Soil and Seasonal Conditions: Moist seedbed - Generally good growing conditions.

Reliability of Test: Very good

Cooperator: F. & M. Beet Sugar Association Year: 1962

Location: Detroit Stake farm, Merrill, Michigan Expt: 12

5 X 6 Rectangular Lattice Design - 6 repl. - Analyzed as Randomized Block

(Results given as 6 plot averages)

Variety and Description		Acre-Yield Gross Sugar Pounds	Acre-Yield Roots Tons	Sucrose Percent	Purity Percent	Beets per 100' of row Number
61B24-0	1	6324 16	18.40 18	17.20 14	83.72 6	97
61B23-0	2	5812	17.22	16.83	81.26	98
61B22-0	3	6689 10	20.08 8	16.65	82.44 19	97
61AB21-0	4	6107	18.31	16.70	81.96	104
129ms X US 401(4N)	5	7459 1	23.31 1	15.98	82.18 22	72
126ms X SP 5460-0		7310 2	20.65 4	17.75 2	81.44	98
(122X127) X 129 X US 401(4N)		6641 12	20.44 7	16.23	83.05 11	68
(122X128) X 126ms X 5460-0		6973 6	20.79 3	16.78	80.92	86
128ms X SP 5460-0	9	7053 4	21.03 2	16.78	81.65	77
128ms X US 401(4N)	10	6993 5	20.49 6	17.06 19	82.63 16	94
128ms X 5822-0	11	7107 3	19.92 9	17.83 1	85.53 2	101
SP 61602-01	12	6655 11	19.37 12	17.18 15	82.16 23	107
SP 61605-01	13	5537	16.00	17.31 12	82.44 19	94
SP 61606-01	14	6307 17	18.30 19	17.28 13	83.40 8	112
SP 61607-01	15	6212	18.42 17	16.85	82.76 13	97
SP 61613-01	16	6048	17.16	17.64 5	82.93 12	107
SP 61618-01	17	6046	17.30	17.48 6	82.46 17	103
SP 61622-01	18	6566 15	18.94 14	17.34 10	84.39 4	98
SP 61623-01	19	6112	17.27	17.71 3	82.29 20	98
SP 61627-01	20	5910	17.33	17.06 19	83.25 10	106
SP 61628-01	21	6588 14	19.23 13	17.13 16	83.74 5	99
SP 60194-01	22	6260	18.70 16	16.78	84.45 3	106
SP 60195-01	23	6069	17.83	17.07 17	81.19	100
SP 60196-01	24	6299	18.07 20	17.41 7	83.70 7	110
1539H1	25	6702 9	20.59 5	16.26	81.12	98
SP 601000-0	26	6141	17.69	17.38 9	82.20 21	103
SP 60300-0	27	6639 13	18.79 15	17.69 4	86.25 1	105
122 X 128 X 126 X SP5822-028		6892 8	19.88 10	17.32 11	83.33 9	95
122 X SP 5460-0	29	6905 7	19.86 11	17.38 9	82.71 15	102
SP 5481-0	30	6362 15	19.14 14	16.58	82.75 14	101
General Mean		6491	19.02	17.09	82.81	98
S.E. Var. Mean		255.8	.6690	.3053	1.010	4.1
S.E. Var. Mean as % Gen.Mean		3.94	3.52	1.79	1.22	4.19
Diff. for Sig. (odds 19:1)		716	1.87	0.85	2.83	12

Random Block Analysis — Variance Table

Source of Variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Purity	Beets per 100 of row
Between replications	5	4,585,350	40.6736	4.4352	8.1036	96
Between varieties	29	1,288,481	14.2980	1.3707	9.4752	624
Remainder - Error	145	392,638	2.6892	0.5592	6.1285	101
Total	179					
Calculated F. value	29/145	3.28**	5.32**	2.45**	1.55*	6.18*

Cooperator: Combined Analysis Year: 1962

Location: Fort Jennings, Ohio, (p.114) and Merrill, Michigan, (p.116) Expt: 32

30 varieties x 2 locations

Variety and Description		Acre-Yield Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
		Pounds	Tons	Percent	Percent	Number
61B24-0	1	6674 14	19.96	16.82	83.86 7	96
61B23-0	2	5991	17.82	16.80	80.97	95
61B22-0	3	6817 12	20.22 11	16.85	83.31 13	98
61AB21-0	4	6422	19.28	16.66	82.53	100
129ms X US401(4N)	5	7901 1	23.87 1	16.53	82.86	84
126ms X SP5460-0	6	7455 4	21.35 7	17.47 2	82.52	97
(122 x 127)X 129 X US401(4N)	7	7297 7	22.08 3	16.50	83.45 11	83
(122 x 128)X 126MS X 5460-0	8	7206 8	21.44 5	16.80	82.41	92
128ms X 5460-0	9	7490 3	22.01 4	17.00 14	83.04 17	87
128ms X US 401(4N)	10	7434 5	22.27 2	16.72	82.70	94
128ms X 5822-0	11	7584 2	21.38 6	17.76 1	85.06 1	102
SP61602-01	12	6423	19.09	16.85	82.18	99
SP61605-01	13	6156	17.85	17.25 10	83.18 15	96
SP61606-01	14	6576	18.99	17.35 8	84.17 4	108
SP61607-01	15	6573	19.32	17.03	83.28 14	98
SP61613-01	16	6576	19.01	17.35 8	83.62 9	107
SP61618-01	17	6191	17.89	17.30 9	82.89	101
SP61622-01	18	6975 10	20.37 10	17.11 11	83.68 8	101
SP61623-01	19	6377	18.31	17.45 3	82.99	101
SP61627-01	20	6393	19.04	16.83	82.39	104
SP61628-01	21	6632 16	19.42	17.06 12	83.49 10	103
SP60194-01	22	6500	19.28	16.87	83.42 12	102
SP60195-01	23	6129	18.27	16.76	82.48	100
SP60196-01	24	6794 13	19.50	17.42 5	84.29 3	112
1539H1	25	6360	19.95	15.89	81.55	97
SP601000-0	26	6144	18.03	17.04 13	82.52	99
SP 60300-0	27	6649 15	19.72	16.89	84.52 2	101
122x128x126xSP5822-0	28	7381 6	21.17 8	17.43 4	83.91 5	100
122xSP5460-0	29	7005 9	20.13 12	17.40 6	83.04 17	98
SP5481-0	30	6902 11	20.44 9	16.85	83.86 7	102
General Mean		6767	19.92	17.00	83.14	99
S.E. Var. Mean		240.0	.6490	.2771	.7285	5.0
S. E. Var. Mean as % Gen. Mean		3.55	3.26	1.63	0.88	5.05
Diff. for Sig. (odds 19:1)		694	1.88	0.80	NS	NS

Random Block Analysis — Variance Table

Source of variation	D/F	Mean Square: Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between Locations	1	4,583,084	47.9450	.4426	9.0480	35
Between varieties	29	509,290	4.5110	.3028	1.5875	79
Remainder - L X V	29	115,199	.8425	.1536	1.0615	51
Total	59					
Calculated F values 29/59		4.42**	5.35**	1.97*	NS	NS

Cooperator: Combined Analysis Year: 1962

(p.120) (p.122)

Location: Bay City and Linwood, Michigan Expt: 43

18 varieties x 2 locations

Variety and Description		Acre-Yield Gross Sugar Pounds	Acre-Yield Roots Tons	Sucrose Percent	Purity Percent	Beets per 100' of row Number
62B1X04	1:	6049 12	16.59 13	18.06 1	86.52 5	76
62B2X04	2:	5770 14	16.64 12	17.12 11	85.60 13	83
62B4X04	3:	6131 11	17.50 10	17.37 7	86.04 9	71
62B1X05	4:	7132 1	19.72 2	17.92 3	87.69 1	83
62B2X05	5:	6517 7	18.87 5	16.95 13	85.68 12	78
62B3X05	6:	5800 13	17.23 11	16.62 15	85.73 11	76
62B1X06	7:	6777 3	18.66 7	18.01 2	87.48 2	77
62B2X06	8:	6787 2	19.28 3	17.45 5	85.90 10	76
62B3X06	9:	6745 4	19.78 1	16.76 14	85.43 14	81
62B1X09	10:	6491 8	17.91 8	17.91 4	87.25 3	77
62B2X09	11:	6280 10	17.84 9	17.40 6	86.25 7	77
62B3X09	12:	6320 9	18.10 8	17.32 8	85.38 15	83
62B4X09	13:	5690 15	16.29 14	17.25 10	86.71 4	73
62B1X010	14:	6676 5	19.01 4	17.27 9	86.23 8	78
62B2X010	15:	6528 6	18.80 6	17.10 12	86.47 6	77
62B4X010	16:					
62B1X07	17:	6469	17.93	17.92	87.63	77
62B4X03	18:	6070	17.23	17.43	87.37	73
62B1X03	19:	6589	18.51	17.65	85.58	81
General Mean		6379	18.10	17.42	86.39	78
S.E. Var. Mean		326.4	0.955	.2487	.6742	3.3
S. E. Var. Mean as % Gen. Mean		5.12	5.28	1.43	0.78	4.23
Diff. for Sig. (odds 19:1)		NS	NS	0.74	NS	NS

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Random Block Analysis — Variance Table

Source of Variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between locations	1	118,720,359	698.8533	21.9594	.2988	2742
Between varieties	17	315,247	2.2479	.3681	1.3200	26
Remainder - Error	17	213,105	1.8240	.1237	.9092	22
Total	35					
Calculated F. value	17/17	NS	NS	2.97*	NS	NS

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Martin Helmreich farm. Bay City, Michigan

Cooperation: F & M Beet Sugar Association, Monitor Sugar Division

Date of Planting: April 27, 1962

Date of Harvest: October 19, 1962

Experimental Design: 5 X 6 Rectangular Lattice

Size of Plots: 4 rows X 20 feet - 28" between rows

Harvested Area per plot for Root Yield: 4 rows X 20 feet

Samples for Sucrose Determination: 2 samples of 10 beets each taken consecutively from the outside harvested rows.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: 1959 - Alfalfa,
1960 - Beans 300# 6-24-12
1961 - Beans 300# 6-24-12

Fertilization of Beet Crop: 750# 6-24-12 banded at planting time,
400# 12-12-12 sidedressed

Black Root Exposure: Slight

Leaf Spot Exposure: Slight

Other Diseases and Pests: None

Soil and Seasonal Conditions: Moist seedbed - Generally good growing conditions.

Reliability of Test: Good

Cooperator: F & M Beet Sugar Association, Monitor Sugar Div. Year: 1962

Location: Martin Helmreich farm, Bay City, Mich. Expt: 13

5 X 6 Rectangular Lattice Design - 6 repl. - Analyzed as Randomized Block

28 varieties x 6 replications (2 entries deleted due to lack of stand)

(Results given as 6 plot averages)

Variety and Description		Acre-Yield Gross Sugar Pounds	Roots Tons	Sucrose Percent	Purity Percent	Beets per 100' of row Number
62B1X04	1:	7406	19.63	18.83	87.40	84
62B2X04	2:	7197	19.99	17.94	86.55	88
62B4X04	3:	7662	21.28	18.01	85.77	81
62B1X05	4:	8878 3	23.61	18.80	88.28	90
62B2X05	5:	8746 4	24.22	18.08	84.97	91
62B3X05	6:	7294	20.40	17.88	85.16	82
62B1X06	7:	8616 6	23.16	18.60	86.95	88
62B2X06	8:	8538 7	23.69	18.03	85.91	85
62B3X06	9:	8689 5	24.06	18.05	86.48	87
62B1X09	10:	8453 9	22.62	18.68	87.74	83
62B2X09	11:	8337	22.95	18.18	86.21	81
62B3X09	12:	8087	22.62	17.88	85.14	92
62B4X09	13:	7319	20.25	18.03	87.00	84
62B1X010	14:	9197	25.44	18.11	86.28	94
62B2X010	15:	8923 2	25.09	17.79	87.40	87
62B4X010	16:					
62B1X07	17:	8178	22.29	18.34	88.18	86
62B4X03	18:	7912	21.90	18.03	86.43	85
62B1X03	19:	8077	22.00	18.33	84.76	86
62B2X03	20:	8303	22.80	18.22	87.51	90
62B3X03	21:	7204	19.26	18.72	86.45	89
62B2X07	22:	8276	22.00	18.82	87.84	88
62B3X07	23:	7981	21.45	18.58	86.17	81
62B4X07	24:	9319 1	24.97	18.66	88.37	86
62B3X04	25:	7666	21.26	18.03	85.59	89
62B4X08	26:					
62B2X02	27:	7622	21.14	18.01	86.10	85
62B4X02	28:	8129	22.43	18.11	85.84	81
62B1X02	29:	7932	21.53	18.43	85.86	90
62B1X08	30:	8473 8	22.83	18.56	87.42	88
General Mean		8158	22.32	18.27	86.56	86
S.E. Var. Mean		389.6	1.026	.2503	.7935	3.7
S. E. Var. Mean as % Gen. Mean		4.78	4.60	1.37	0.92	4.34
Diff. for Sig. (odds 19:1)		1090	2.87	0.70	2.22	NS

Random Block Analysis — Variance Table

Source of Variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between replications	5	10,216,736	67.3533	.6577	9.3791	180
Between varieties	27	2,121,309	16.0114	.6931	6.4783	77
Remainder - Error	135	911,074	6.3200	.3761	3.7788	84
Total	167					
Calculated F. value	27/135	2.33**	5.92**	1.84*	1.71*	NS

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Parson Brothers Farm, Linwood, Michigan

Cooperation: F & M Beet Sugar Association

Date of Planting: April 30, 1962

Date of Harvest: October 9, 1962

Experimental Design: 4 X 5 Rectangular Lattice

Size of Plots: 4 rows X 20 feet. Rows 28" apart

Harvested Area per plant for Root Yield: 4 rows X 20'

Samples for Sucrose Determination: 2 samples of 10 consecutive beets each from the outside harvested rows.

Stand Counts: Harvested beets counted when weighed.

Recent Field History:
1959 - Peas - 200# 5-20-20
1960 - Wheat - 300# 5-20-20
1961 - Beets - 500# 12-12-12 broadcast; 200# 5-20-20 with magnesium and Boron in the row.

Fertilization of Beet Crop: 60# Liquid Nitrogen broadcast, 300# 5-20-20 with magnesium and Boron

Black Root Exposure: Moderate

Leaf Spot Exposure: Heavy

Other Diseases and Pests: None

Soil and Seasonal Conditions: Excessively heavy rains early in season

Reliability of test: Fair

Cooperator: F & M Beet Sugar Association, Monitor Sugar Div. Year: 1962

Location: Parson Brothers farm, Linwood, Michigan Expt: 14

4 X 5 Rectangular Lattice Design - 6 repl. - Analyzed as Randomized Block

(Results given as 6 plot averages)

Variety and Description		Acre-Yield Gross Sugar Pounds	Acre-Yield Roots Tons	Sucrose Percent	Purity Percent	Beets per 100' of row Number
62B1X04	1:	4692	13.56	17.29	85.64	68
62B2X04	2:	4343	13.28	16.30	84.65	78
62B4X04	3:	4600	13.73	16.74	86.32	61
62B1X05	4:	5385 1	15.83	17.03	87.09	77
62B2X05	5:	4289	13.52	15.82	86.39	65
62B3X05	6:	4305	14.06	15.36	86.30	69
62B1X06	7:	4937 4	14.16	17.43	88.01	67
62B2X06	8:	5036 3	14.86	16.88	85.90	67
62B3X06	9:	4802 5	15.50	15.48	84.38	76
62B1X09	10:	4529	13.21	17.13	86.76	70
62B2X09	11:	4223	12.72	16.63	86.30	74
62B3X09	12:	4554	13.58	16.76	85.63	74
62B4X09	13:	4062	12.33	16.48	86.43	62
62B1X010	14:	4155	12.58	16.43	86.17	62
62B2X010	15:	4134	12.51	16.42	85.54	67
62B4X010	16:	2453	7.97	15.20	85.50	29
62B1X07	17:	4761	13.58	17.51	87.09	67
62B4X03	18:	4228	12.56	16.83	88.32	60
62B1X03	19:	5102 2	15.02	16.98	86.41	77
SL 122 X SP 5460-0(Com'l)	20:	4043	12.33	16.42	86.63	74
General Mean		4,431	13.34	16.55	86.27	67
S.E. Var. Mean		273.7	.7653	.2846	.9507	3.8
S. E. Var. Mean as % Gen. Mean		6.18	5.74	1.72	1.10	5.65
Diff. for Sig. (odds 19:1)		768	2.15	0.80	NS	11

Random Block Analysis — Variance Table

Source of Variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between replications	5	1,447,525	8.0971	2.2718	16.9682	199
Between varieties	19	2,161,156	16.0066	2.6766	5.6429	665
Remainder - Error	95	449,489	3.5146	.4860	5.4245	86
Total	119					
Calculated F. value	19/95	4.81**	4.55**	5.51**	NS	7.73**

GENERAL INFORMATION - 1962 Variety Trials

Conducted by - W. W. Snow

Location - W. O. A.S. , Ridgetown, Ontario

Cooperation - C & D Sugar Co. Ltd.

Date of Planting - April 19

Date of Harvest - October 26

Experimental Design - 4 x 4 Balanced Lattice, Repeated

Size of Plots - 3 rows x 24" x 20'

Harvested area per plot for root yield - 3 rows x 24" x 14'

Samples for sucrose determination - 2 samples x 10 beets/plot
total of 4 determinations/plot

Stand counts - roots counted when weighed

Recent field history - Field Beans as preceding crop

Fertilization on beet crop - 90-90-90

Black root exposure - none

Leaf spot exposure - considerable

Other diseases and pests - none

Soil and seasonal conditions - average

Reliability of test - fair-good

SUGAR BEET VARIETY TRIAL - 1962 - W.O.A.S.

Date Planted - April 27

Date Harvested - Oct. 26

STRAIN	CERCOSPORA RATING	NO. OF ROOTS AVE.	WEIGHT OF TOPS TONS PER ACRE	WEIGHT OF ROOTS TONS PER ACRE	SUGAR %	WT. OF SUGAR LBS. PER ACRE
"B"	5.2	38.5	9.0	28.0	16.5 9	9200 1
U.S. 401	4.8	40.7	8.3	26.4	16.6 7	8770 2
S.P. 5481-0	4.3	41.5	9.6	26.0	15.9 14	8740 3
1375 (F60-561HOxSP5460-0)	4.7	39.5	8.9	25.7	16.6 7	8570 4
S.P. 61624-0	4.3	39.6	9.0	25.2	16.3 12	8200 7
"D"	5.8	36.8	6.9	24.8	17.3 2	8550 5
"A"	6.5	39.6	7.8	24.7	15.1 15	7430 13
C.S. 7	6.2	39.7	5.8	24.6	14.8 16	7280 14
1376 (A1-10xA1-12xSP5460-0)	4.7	41.8	8.2	23.9	16.5 9	7890 8
K.W. Cercopoly	5.6	37.9	8.9	23.7	17.5 1	8290 6
1377 (F59-569HOxSP5460-0)	5.2	40.3	9.3	23.7	16.4 11	7740 10
S.L. 122xS.P. 5460-0	4.9	40.9	8.3	23.5	15.9 14	7480 11
S.L. 6161-0	4.2	39.9	7.9	23.4	16.6 7	7760 9
C.S. 7-8	5.2	37.7	8.9	22.7	16.4 11	7440 12
S.P. 6162-0	5.4	37.2	7.9	21.8	16.8 4	7200 15
"C"	7.3	37.4	8.0	19.4	16.8 4	6520 16
L.S.D. at 5% level				4.9		
L.S.D. at 1% level				6.5		
C.V.				2.7%		

AGRONOMIC EVALUATION TEST- 1962

Conducted by : Myron D. Groskopp

Location : University of Wisconsin, Branch Experiment Station, Hancock, Wisconsin.

Cooperation : University of Wisconsin.

Date of Planting : April 28, 1962.

Date of Harvest : October 11, 1962.

Experimental Design: 8 Var. 5 repl. Analyzed as random block.

Size of Plots : 1 row x 120 feet. 24" between rows.

Harvested area per plot for Root Yield : 1 row x 120 feet.

Samples for Sucrose Determination :

Stand Counts :

Recent Field History : Alfalfa-Potato rotation.

Fertilization of Beet Crop : 300# 8-16-16
300# 33-0-0 sidedressed 6/12/62.

Irrigated : May 28 1.5"/acre
June 2 1.5"/acre
August 1 1.5"/acre
August 8 1.5"/acre
August 21 1.5"/acre

Block Root Exposure :

Other Diseases and Pests : Rhizoctonia solani--spots killed out completely. Badly infected areas were not harvested for yield.

Cooperator: University of Wisconsin, Branch Experiment Station Year: 1962

Location: Hancock, Wisconsin Expt: ____

Randomized Block

(Results given as 5 plot averages)

Variety and Description	Acre-Yield Gross Sugar Pounds	Roots Tons	Sucrose Percent	Purity Percent	Beets per 100' of row Number
SP 6161-0		27.7 4			
SP 6162-0		21.1 8			
SP 61624-0		26.9 5			
F 60-561 HO X SP 5460-0		29.1 1			
F 59-569 HO X SP 5460-0		27.7 4			
(AI-10 X AI-12) X SP 5460-0		25.7 7			
SL 122 MS X SP 5460-0		27.9 2			
SP 5481-0		26.7 6			
General Mean		26.6			
S.E. Var. Mean		1.17			
S.E. Var. Mean as % Gen. Mean		4.40			
Diff. for Sig. (odds 19:1)		3.4			

Latin Square Analysis

Variance Table

Source of Variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Purity	Beets per 100' of row
Between replications	4		24.7750			
Between varieties	7		29.7586			
Remainder - Error	28		6.8418			
Total	39					
Calculated F. value	7/28		4.35**			

AGRONOMIC EVALUATION TEST, 1962

Conducted by: Richard Zielke, H. L. Bush, R. K. Oldemeyer, and D. L. Sunderland

Location: Kenneth Krauss Farm, Findlay, Ohio

Cooperation: Northern Ohio Sugar Company

Date of Planting: April 4, 1962

Date of Harvest: October 20, 1962

Experimental Design: Triple Rectangular Lattice

Size of Plots: 4 rows x 22 feet planted (22-inch rows)

Harvest Area per Plot for Root Yield: 4 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand Counts and Bolter Counts: Beets counted in laboratory for harvest stand. No bolters developed.

Recent Field History: Red Clover - Grass Sod

Fertilization of Beet Crop: 100 pounds N, 100 pounds P_2O_5 and 100 pounds K_2O plowed down. 150 pounds 6-24-12 in row

Leaf Spot Exposure: Severe, September development

Black Root Exposure: Mild

Curly Top Exposure: None noted

Other Diseases: Rhizoctonia crown rot caused extensive loss in stands over part (1/4) of the plot area.

Soil and Seasonal Conditions: Very dry, almost drouthy conditions prevailed throughout the summer. Rain occuring during August produced this crop.

Cooperator: Northern Ohio Sugar Company by Richard Zielke, H. L. Bush, R. K. Oldemeyer and D. L. Sunderland

(General Variety Test)

Location: S. K. Krauss Farm, Findlay, Ohio Year: 1962

(Results given as 12 plot averages)

Variety	Acre Yield: Sugar: Recoverable[a] (lbs.)	Acre Yield: Sugar: Gross (lbs.)	Acre Yield: Roots (tons)	Sucrose (%)	Thin Juice App. Purity (%)	Leaf Spot[d] (10/5/62)	Beets[e] per 100 ft. (No.)
SP5822-0	7380	8419	26.26 3	16.03 1	94.05 1	1.8	122
SP61624-0	7046	8267	26.79 1	15.43 3	92.78 3	3.2	120
SP5481-0	6814	7997	25.83 4	15.48 2	92.77 4	3.2	124
US401	6718	8039	26.62 2	15.10 6	91.94 6	4.2	119
SP60195-01	6422	7483	24.31 5	15.39 5	93.09 2	3.1	119
SP6161-0	6083	7163	24.15 6	14.83 7	92.32 5	3.6	123
SL122MS x 5460-0	5989	7239	23.52 7	15.39 5	91.48 7	5.0	130
General Mean[f]	6724	7942	25.26	15.72	92.48	-	-
S.E. Variety Mean (Sm)	-	201.87	.5999	.2007	.2733	-	-
Sm/Gen. Mean (%)	-	2.54	2.37	1.28	0.30	-	-
LSD 5% pt.	518[b]	612	1.74	0.56	0.76	-	-

Variance Table[c]

Source of Variance	DF	Mean Squares: Roots (lbs.)[h]	Mean Squares: Sucrose (%)	Mean Squares: Purity (%)
Replicates	11	1112.4964	.6309	1.4236
Component (a)	36	233.5100	.2631	.8441
Component (b)	12	99.2500	.2242	1.0000
Blocks (eliminating varieties)	48	199.9450	.2533	.8831
Varieties (ignoring blocks)	19	693.3832	3.3674	4.9600
Error (Intra-block)	161	158.6302[g]	.2380	.9004
Error (Random Block)	209	168.1188	.2415[g]	.8964[g]
Total	239	253.3413	.5079	1.2437
Calculated F value		4.37**	13.94**	5.53**

(a, (b, (c See page 138.

(d 0 = no evidence of disease, 10 = complete necrosis due to leaf spot

(e Harvest stand

(f General mean for 20 varieties in test

(g Error term used

(h Pounds per plot

AGRONOMIC EVALUATION TEST, 1962

General Variety Test

Conducted by: Richard Zielke, H. L. Bush, R. K. Oldemeyer, and D. L. Sunderland

Location: Glenn Haas Farm, Fremont, Ohio

Cooperation: Northern Ohio Sugar Company

Date of Planting: April 10, 1962

Date of Harvest: November 19 & 20, 1962

Experimental Design: Triple Rectangular Lattice

Size of Plots: 4 rows x 22 feet planted (30-inch rows)

Harvest Area per Plot for Root Yield: 4 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand Counts and Bolter Counts: Beets counted in laboratory for harvest stand. No bolters developed.

Recent Field History: Soybeans

Fertilization of Beet Crop: 45 pounds P_2O_5 and 120 pounds K_2O plowed down.

175 pounds 11-48-0 in row
80pounds N as anhydrous ammonia sidedressed on June 20.

Leaf Spot Exposure: Mild to moderate, late development

Black Root Exposure: Moderate to severe

Curly Top Exposure: None noted

Other Diseases: Rhizoctonia crown rot caused some loss of stands.

Soil and Seasonal Conditions: Very dry at planting time but fairly normal percipitation and temperatures prevailed throughout the summer with 2 inches of rain in October. Beets were harvested 3 weeks after a freeze was encountered on the plot area on October 25, 1962.

Cooperator: Northern Ohio Sugar Company by Richard Zielke, H. L. Bush, R. K. Oldemeyer and D. L. Sunderland

(General Variety Test)

Location: Glen Haas Farm, Fremont, Ohio   Year: 1962

(Results given as 12 plot averages)

Variety	Acre Yield: Sugar: Recoverable[a] (lbs.)	Acre Yield: Sugar: Gross (lbs.)	Acre Yield: Roots (tons)	Sucrose (%)	Thin Juice App. Purity (%)	Leaf Spot[d] (10/6/62)	Beets[e] per 100 ft. (No.)
SP5822-0	7462	8813	27.15 1	16.23 1	92.46 1	0.8 1	114
SP5481-0	6853	8271	26.09 4	15.85 2	91.52 3	2.3 5	119
US401	6724	8312	27.11 2	15.33 6	90.55 4	2.9 6	101
SP61624-0	6625	8214	26.43 3	15.54 5	90.43 5	1.5 2	104
SP60195-01	6510	7847	25.12 5	15.62 3	91.60 2	1.8 3	105
SL122MS x 5460-0	5884	7363	23.63 7	15.58 4	90.03 6	3.5 7	108
SP6161-0	5772	7259	24.23 6	14.98 7	89.88 7	1.9 4	102
General Mean[f]	6257	7694	24.46	15.73	90.74	-	-
S.E. Variety Mean (Sm)	-	161.54	.4729	.1283	.3108	-	-
Sm/Gen. Mean (%)	-	2.10	1.93	0.82	0.34	-	-
LSD 5% pt.	398[b]	489	1.46	0.36	0.86	-	-

Variance Table[c]

Source of Variance	DF	Mean Squares: Roots (lbs.)[h]	Mean Squares: Sucrose (%)	Mean Squares: Purity (%)
Replicates	11	1768.6855	3.8491	31.2809
Component (a)	36	662.5636	.0242	1.3592
Component (b)	12	100.9767	.0642	1.1192
Blocks (eliminating varieties)	48	522.1669	.0342	1.2992
Varieties (ignoring blocks)	19	2671.7395	1.7063	5.7484
Error (Intra-block)	161	183.3102[g]	.2466	1.1170
Error (Random Block)	209	261.1337	.1978[g]	1.1589[g]
Total	239	522.1571	.4858	2.9101
Calculated F value		14.57**	8.63**	4.96**

(a, (b, (c See page 138.

(d 0 = no evidence of disease, 10 = complete necrosis due to leaf spot

(e Harvest stand

(f General mean for 20 varieties in test

(g Error term used

(h Pounds per plot

AGRONOMIC EVALUATION TEST, 1962

SUPPLEMENTAL VARIETY TEST

Conducted by: Richard Zielke, H. L. Bush, R. K. Oldemeyer and D. L. Sunderland

Location: Glenn Haas Farm, Fremont, Ohio

Cooperation: Northern Ohio Sugar Company

Date of Planting: April 11, 1962

Date of Harvest: November 15, 1962

Experimental Design: Triple Rectangular Lattice

Size of Plots: 2 rows x 22 feet planted (30-inch rows)

Harvest Area per Plot for Root Yield: 2 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand Counts and Bolter Counts: Beets counted in laboratory for harvest stand. No bolters developed.

Recent Field History: Soybeans

Fertilization of Beet Crop: 48 pounds P_2O_5 and 120 pounds K_2O plowed down.
175 pounds 11-48-0 in row
80 pounds N as anhydrous ammonia sidedressed on June 20.

Leaf Spot Exposure: Mild to moderate, late development

Black Root Exposure: Moderate to severe

Curly Top Exposure: None noted

Other Diseases: Rhizoctonia crown rot caused some loss of stands.

Soil and Seasonal Conditions: Very dry at planting time but fairly normal precipitation and temperatures prevailed throughout the summer with 2 inches of rain in October. Beets were harvested 3 weeks after a freeze was encountered on the plot area on October 25, 1962.

Cooperator: Northern Ohio Sugar Company by Richard Zielke, H. L. Bush, R. K. Oldemeyer and D. L. Sunderland

Supplemental Variety Test

Location: Glen Haas Farm, Fremont, Ohio Year: 1962

(Results given as 6 plot averages)

Variety	Acre Yield: Sugar: Recoverable (a (lbs.)	Acre Yield: Sugar: Gross (lbs.)	Acre Yield: Roots (tons)	Sucrose (%)	Thin Juice App. Purity (%)	Leaf Spot (d (10/17/62)	Beets (e per 100 ft. (No.)
SP6122-0	7262	8473	26.51 1	15.98 2	93.00 2	1.0	115
SP60194-01	6768	8132	25.93 2	15.68 7	91.74 5	1.3	112
SP61151-0	6762	7813	24.82 3	15.74 6	93.48 1	0.7	123
SP6180-0	6571	7725	24.14 4	16.00 1	92.66 3	0.8	109
SP5481-0	6436	7613	23.85 5	15.96 4	92.39 4	2.3	123
Inc. of SP59B18-0 (i	5890	7125	22.32 6	15.96 4	91.42 6	1.7	87
SP6162-0	5696	6926	21.89 7	15.82 5	91.20 7	1.7	103
General Mean (f	6164	7356	23.14	15.90	91.97	-	-
S.E. Variety Mean (Sm)	-	382.49	1.1725	.1821	.3491	-	-
Sm/Gen. Mean (%)	-	5.20	5.07	1.15	0.38	-	-
LSD 5% pt.	903 (b	1079	3.29	0.55	1.03	-	-

Variance Table (c

Source of Variance	DF	Mean Squares: Roots (lbs.) (h	Mean Squares: Sucrose (%)	Mean Squares: Purity (%)
Replicates	5	435.5660	1.5060	6.9560
Component (a)	12	81.3342	.3317	.5633
Component (b)	12	59.7083	.4958	1.6392
Blocks (eliminating varieties)	24	70.5213	.4138	1.1013
Varieties (ignoring blocks)	19	456.7442	.5779	4.5521
Error (Intra-block)	71	164.6904	.1989 (g	.7308 (g
Error (Random Block)	95	140.9003 (g	.2532	.8244
Total	119	203.7101	.3576	1.6772
Calculated F value		3.24**	2.91**	6.23**

(a, (b, (c See page 138.

(d 0 = no evidence of disease, 10 = complete necrosis due to leaf spot

(e Harvest stand

(f General mean for 20 varieties in test

(g Error term used

(h Pounds per plot

(i Increased by GW, essentially an F_2 tested here

AGRONOMIC EVALUATION TEST, 1962

General Variety Test

Conducted by: Richard Zielke, H. L. Bush, R. K. Oldemeyer, and D. L. Sunderland

Location: George Riehm Farm, Old Fort, Ohio

Cooperation: Northern Ohio Sugar Company

Date of Planting: April 12, 1962

Date of Harvest: November 6, 1962

Experimental Design: Triple Rectangular Lattice

Size of Plots: 4 rows x 22 planted (30-inch rows)

Harvest Area per Plot for Root Yield: 4 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand Counts and Bolter Counts: Beets counted in laboratory for harvest stand. No bolters developed.

Recent Field History: Wheat (1961) with clover plowed down in spring

Fertilization of Beet Crop: 600 pounds 0-20-20, 500 pounds 21% N., and 120 pounds 0-0-60 plowed down. 250 pounds 5-20-20 in row.

Leaf Spot Exposure: Severe, September development

Black Root Exposure: Mild to moderate

Curly Top Exposure: None noted

Other Diseases: Rhizoctonia crown rot caused slight loss in stands

Soil and Seasonal Conditions: Normal precipitation and temperatures prevailed through the summer with 2 inches of rain during October. Beets were harvested 1½ weeks after a freeze and 2 inches of snow was encountered on the plot area on October 25, 1962.

Cooperators: Northern Ohio Sugar Company by Richard Zielke, H. L. Bush, R. K. Oldemeyer and D. L. Sunderland
(General Variety Test)

Location: Old Fort, Ohio Year: 1962

(Results given as 12 plot averages)

Variety	Acre Yield: Sugar: Recoverable[a] (lbs.)	Acre Yield: Sugar: Gross (lbs.)	Acre Yield: Roots (tons)	Sucrose (%)	Thin Juice App. Purity (%)	Leaf Spot[d] (9/17/62)	Beets[e] per 100 ft. (No.)
SP5822-0	7915	9172	29.80 3	15.39 1	93.35 1	1.5	109
SP5481-0	7723	9018	30.04 2	15.01 3	93.02 2	3.0	127
SP60195-01	7280	8625	28.41 5	15.18 2	92.38 3	2.4	113
SP6161-0	7095	8478	28.45 4	14.90 5	92.00 5	2.8	118
US401	7034	8662	30.18 1	14.35 7	90.76 7	3.7	113
SP61624-0	6865	8254	28.15 6	14.66 6	91.76 6	2.8	120
SL122MS x 5460-0	6844	8124	27.19 7	14.94 4	92.29 4	4.4	118
General Mean[f]	6923	8202	27.07	15.15	92.36	-	-
S.E. Variety Mean (Sm)	-	197.71	.5219	.2190	.4930	-	-
Sm/Gen. Mean (%)	-	2.41	1.93	1.45	0.53	-	-
LSD 5% pt.	462[b]	548	1.45	0.61	1.37	-	-

Variance Table[c]

Source of Variance	DF	Mean Squares: Roots (lbs.)[h]	Mean Squares: Sucrose (%)	Mean Squares: Purity (%)
Replicates	5	399.0509	.9618	2.4036
Component (a)	36	162.8858	.3753	.6967
Component (b)	12	213.9000	.5208	3.7492
Blocks (eliminating varieties)	48	175.6394	.4117	1.4598
Varieties (ignoring blocks)	19	4477.9710	3.2353	9.0195
Error (Intra-block)	161	237.4604	.6241	3.3505
Error (Random Block)	209	223.2622[g]	.5753[g]	2.9163[g]
Total	239	569.5933	.8046	3.3779
Calculated F value		20.06**	5.62**	3.09**

(a, (b, (c See page 138.
(d 0 = no evidence of disease, 10 = complete necrosis due to leaf spot
(e Harvest stand
(f General mean for 20 varieties in test
(g Error term used
(h Pounds per plot

AGRONOMIC EVALUATION TEST, 1962

Supplemental Variety Test

Conducted by: Richard Zielke, H. L. Bush, R. K. Oldemeyer, and D. L. Sunderland

Location: George Riehm Farm, Old Fort, Ohio

Cooperation: Northern Ohio Sugar Company

Date of Planting: April 12, 1962

Date of Harvest: November 6, 1962

Experimental Design: Triple Rectangular Lattice

Size of Plots: 2 rows x 22 feet planted (30-inch rows)

Harvest Area per Plot for Root Yield: 2 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand Counts and Bolter Counts: Beets counted in laboratory for harvest stand. No bolters developed.

Recent Field History: Wheat (1961) with clover plowed down in spring

Fertilization of Beet Crop: 600 pounds 0-20-20, 500 pounds 21% N and 120 pounds 0-0-60 plowed down. 250 pounds 5-20-20 in row

Leaf Spot Exposure: Severe, September development

Black Root Exposure: Mild to moderate

Curly Top Exposure: None noted

Other Diseases: Rhizoctonia crown rot caused slight loss in stands.

Soil and Seasonal Conditions: Normal precipitation and temperatures prevailed through the summer with 2 inches of rain during October. Beets were harvested 1½ weeks after a freeze and 2 inches of snow was encountered on the plot area on October 25, 1962.

Cooperator: Northern Ohio Sugar Company by Richard Zielke, H. L. Bush, R. K. Oldemeyer and D. L. Sunderland

Supplemental Variety Test

Location: Old Fort, Ohio

Year: 1962

(Results given as 6 plot averages)

Variety	Acre Yield: Sugar: Recoverable[a] (lbs.)	Acre Yield: Sugar: Gross (lbs.)	Acre Yield: Roots (tons)	Sucrose (%)	Thin Juice App. Purity (%)	Leaf[d] Spot (9/17/62)	Beets[e] per 100 ft. (No.)
SP61151-0	8089	9256	29.63 2	15.62 1	93.93 1	1.8	115
SP6122-0	7467	8777	29.16 4	15.05 2	92.73 3	1.5	119
SP6180-0	7454	8741	29.43 3	14.85 4	92.83 2	1.8	129
SP5481-0	7449	8912	30.73 1	14.50 5	91.97 4	3.0	132
Inc. of SP59B18-0[i]	6975	8622	28.78 5	14.98 3	90.58 6	2.3	102
SP60194-01	6530	7999	27.87 6	14.35 7	91.00 5	3.0	133
SP6162-0	6397	7904	27.31 7	14.47 6	90.62 7	2.7	127
General Mean[f]	7415	8921	30.41	14.67	91.68	-	-
S.E. Variety Mean (Sm)	-	339.35	.9852	.2929	.5461	-	-
Sm/Gen. Mean (%)	-	3.80	3.24	2.00	0.60	-	-
LSD 5% pt.	805[b]	969	2.83	0.82	1.53	-	-

Variance Table[c]

Source of Variance	DF	Mean Squares: Roots (lbs.)[h]	Mean Squares: Sucrose (%)	Mean Squares: Purity (%)
Replicates	5	129.0760	.9720	6.2540
Component (a)	12	113.1975	.3942	.7667
Component (b)	12	122.7283	.2675	1.1917
Blocks (Eliminating varieties)	24	117.9629	.3308	.9792
Varieties (ignoring blocks)	19	832.2484	.9221	7.3758
Error (Intra-block)	71	99.4021[g]	.5765	2.0634
Error (Random Block)	95	104.0912	.5144[g]	1.7895[g]
Total	119	221.4013	.5987	2.8690
Calculated F Value		8.37**	1.79	4.12**

(a, (b, (c See page 138.
(d 0 = no evidence of disease, 10 = complete necrosis due to leaf spot
(e Harvest stand
(f General mean for 20 varieties in test
(g Error term used
(h Pounds per plot
(i Increased by GW, essentially an F_2 tested here

(a <u>Recoverable</u> <u>Sugar</u>[1/]

A technique, whereby thin juice purity could be determined from small samples was first used in 1953, following methods developed in the G. W. Research Laboratory at Denver. Using the resultant purity figure, a calculated "Recoverable Sugar" is obtained. An example of the calculation is as follows:

Sugar in beets = 12.00%
Standard total losses = 0.30%
Sugar on beets at sugar end - 12.00 - 0.30 = 11.70%

Assume standard molasses purity = 62.5%
100.0 - 62.5 = 37.5% Impurities on solids in molasses

$\frac{62.5}{37.5}$ = 1.6667% Sugar on impurities in molasses

Sugar sacked
85% purity thin juice = 15% impurities
$\frac{15}{85}$ = 17.6471% impurities on sugar

Sugar end = 11.70 x 17.6471% = 2.06471% on beets
Molasses produced = 2.06471 x 1.66667 = 3.4413% on beets
Sugar sacked = 12.00 - (0.30 + 3.4413) = 8.2587%

$$\text{Recoverable sugar} = \frac{8.2587}{12.00} = 68.82\%$$

(b <u>Approximation</u> - Calculated as percentage of "difference required for significance for "gross" sugar on basis of relationship between general means for "Gross" and "Recoverable" sugar.

(c <u>Gross sugar calculated from the formula</u>:

$$\text{S lbs. sugar} = \text{Mean lbs. sugar} \sqrt{\left(\frac{\text{S lbs. beets}}{\text{Mean lbs. beets}}\right)^2 + \left(\frac{\text{S \% sugar}}{\text{Mean \% sugar}}\right)^2}$$

1/ This technique applies to experiments on pages 129, 131, 133, 135, and 137.

PART V

DEVELOPMENT AND EVALUATION of SUGARBEET BREEDING MATERIAL AND VARIETIES CARRYING RESISTANCE TO LEAF SPOT AND CURLY TOP

Foundation Project 25

J. O. Gaskill
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Cooperators conducting tests:

Colorado Agricultural Experiment Station
Holly Sugar Corporation
National Sugar Manufacturing Company
Tribune Branch Station, Kansas
  Agricultural Experiment Station

DEVELOPMENT AND EVALUATION OF SUGARBEET BREEDING MATERIAL AND VARIETIES CARRYING RESISTANCE TO LEAF SPOT AND CURLY TOP, 1962 1/

(A phase of Beet Sugar Development Foundation Project No. 25)

John O. Gaskill

A statement of objectives and a thumbnail sketch of breeding methods were given in Sugar Beet Research, 1961 Report (pages 121 and 122). Breeding and evaluation work were continued in 1962 according to plan. This report is intended primarily as a summary of experimental results of substance, and, consequently, details pertaining to increases and crosses made, work involved in the indexing of lines for the type-O character, results of preliminary tests of new type-O lines for leaf spot resistance, vigor, sucrose, etc., are omitted.

The field work at Ft. Collins in 1962 included a top-cross test for the purpose of obtaining preliminary combining ability information for several monogerm, leaf spot resistant, type-O inbreds, and the results of that test are presented herein. The bulk of this report, however, pertains to the cooperative evaluation of varieties at a number of locations.

1/ This progress report pertains to breeding and evaluation work conducted at Ft. Collins, Colorado, and to cooperative tests conducted at other locations, by various investigators, with results summarized at the Ft. Collins station. The work at Ft. Collins was performed in cooperation with Colorado Agricultural Experiment Station, Beet Sugar Development Foundation, and Board of County Commissioners of Larimer County, and was supported in part by funds contributed by the National Sugar Manufacturing Co.

Top-Cross Test

Parentage of each hybrid in the top-cross test (Experiment 7A) is given in a table summarizing the results, and descriptions of the parental material are presented in a supplementary table. For the most part, the ♀ lines used to produce the Ft. Collins hybrids had reached only the E_2 stage (i.e. the first backcross) in the development of male-sterile equivalents of the type-O lines described. For this reason, the results presented must be considered as preliminary indications, only, of the combining ability of the respective type-O lines. Other factors which dictate the use of caution in evaluating the results include the plot width (single-row) and the severe leaf spot exposure.

On the basis of the results presented, certain of the type-O lines appear to be quite promising and worthy of further evaluation -- e.g., SP 571702-0, FC 502, and SP 581194sl, and possibly others. FC 501 was disappointing and should be de-emphasized.

TOP-CROSS TEST, 1962
Experiment No. 7A, Ft. Collins, Colo.

Description of Parental Material a/

Strain designation	Seed type	LSR b/	CTR b/	Description
Type-O lines:				
FC 501	mm	+++	-?	S_2 inbred, rr, from US 201 MM x SP 51101-mm; low sucrose %; very small roots; high crowns.
FC 502	mm	+++	-?	S_1 inbred, rr, from US 201 MM x V.F. Savitsky #715 mm; good sucrose % (better than SP 5481-0); med. root size; good crowns.
SP 561609-0	mm	±	-?	Uniform inbred, rr, from SP 51101-461 mm; good sucrose % when leaf spot is not a factor; med. root size; good crowns.
SP 571333sl	mm	+++	-?	S_3 inbred, rr, from US 201 MM x type-O mm; low sucrose %; very small roots; rather high crowns.
SP 571702-0	mm	++	-?	Derived (by selfing) from V.F.Savitsky no. 716 mm inbred; medium sucrose % (i.e. about equal to SP 5481-0); RR; med. root size; good crowns.
SP 581194sl	mm	+++	-?	S_1 inbred, rr, from US 201 MM x type-O mm; sucrose % at least equal to SP 5481-0; med. root size; good crowns.
SP 581220sl	mm	++	-?	S_1 inbred, rr, from US 201 MM x type-O mm; sucrose % at least equal to SP 5481-0; med. root size; good crowns.
Pollinators:				
SL 932	MM	-	+++	F_1, CT5aa x CT9A.
SP 5481-0	MM	++	-	Black root-resistant com'l. var.
SP 601153HO	mm	++	-	Sel. from SP 591101-0, the immed. parent of SP 601000-0; a black-root res. var. with equiv. of 1 gen. of sel. for res. to Botrytis (stor. rot).
SP 601161HO	MM	++	+	Second O.P. gen. fol. the cross, (SL 202 & US 22/4) x (US 22/3 x US 201).

a/ This list pertains only to the parents of hybrids produced at Ft. Collins (i.e. all hybrids except entries 722, 723, and 724).

b/ Classification with respect to leaf spot resistance (LSR) and curly top resistance (CTR): +++ = good; ++ = fairly good; + = fair to medium; ± = slight if any; - = none; -? = probably none.

TOP-CROSS TEST, 1962
Experiment No. 7A, Ft. Collins, Colorado

Conducted by: J. A. Elder and J. O. Gaskill

Location: Hospital Farm, Ft. Collins, Colorado; field no. 3.

Cooperation: Colorado Agricultural Experiment Station, National Sugar Manufacturing Company, Beet Sugar Development Foundation, and Board of County Commissioners of Larimer County.

Dates of Planting and Harvest: April 24; Oct. 2.

Experimental Design: Equalized-Random-Block, 24x8; plots 1 row x 24'; rows 20" apart; hand thinned to single-plant hills.

Determination of Root Yield: With minor exceptions, all roots in 20' of row in each plot were hand topped, washed, and weighed.

Determination of Sucrose Percentage: All roots harvested for root yield determination in each plot constituted one sample for sucrose analysis. Duplicate sucrose determinations were made for the composited pulp from each sample.

Stand and Bolter Counts: All hills were counted in each plot on September 17, in the area to be harvested for root yield.

Recent Cropping History: 1959 and 1960, alfalfa; 1961, barley.

Chemicals Applied for Sugarbeet Crop: Treble superphosphate (approximately 280 lbs. per acre) and ammonium nitrate (approximately 87 lbs. per acre) were applied in September, 1961, just before plowing. Shell DD (about 47 gal. per acre) was applied in September, 1961, for sugarbeet nematode control.

Leaf Spot Exposure: Severe.

Sugarbeet Nematode: Mild.

Yellows Virus: Beet yellows or western yellows was general throughout the field; effects probably mild.

Other Diseases and Pests: Negligible.

Soil and Seasonal Conditions: The weather was about normal throughout most of the growing season; drier than usual late in the season. Furrow irrigation was adequate. Inoculation and frequent sprinkling were employed in order to promote the development of leaf spot (*Cercospora beticola*).

Reliability of Test: Good.

TOP-CROSS TEST, FT. COLLINS, COLO., 1962 (Exp. No. 7A)
(Results given as 8-plot averages)

Description	Ft.Collins seed no.	Entry no.	Acre yield: Gross Sucrose	Acre yield: Roots	Sucrose	Leaf spot a/: 8/7	Leaf spot a/: 8/23-24	Vig. b/: 8/23-24	Stand (hills per 100')	Bolters
			Lbs.	Tons	%				No.	%
SP 5481-0 (EL-1023) MM	Acc. 2483	701	3980	13.23	15.04	2.7	2.9	6.0	113.8	0.00
MS (E_2) of SP 571702-0 mm x SP 5481-0 MM	SP 611218H01	702	3960	12.88	15.38	3.4	3.6	6.4	115.4	0.50
MS (E_2) of FC 501 mm x SP 5481-0 MM	SP 611218H02	703	3617	11.99	15.07	2.8	2.7	6.6	119.4	0.00
MS (E_2) of SP 571333sl mm x SP 5481-0 MM	SP 611218H03	704	4528 5	14.65	15.44	3.2	2.9	6.3	115.6	1.60
MS (E_2) of SP 581220sl mm x SP 5481-0 MM	SP 611218H04	705	3873	12.70	15.24	3.4	3.7	5.5	118.1	0.00
MS (E_2) of FC 502 mm x SP 5481-0 MM	SP 611218H05	706	4659 3	14.47	16.09	2.9	2.8	6.1	115.9	1.86
MS (E_2) of SP 581194sl mm x SP 5481-0 MM	SP 611218H06	707	4322	13.55	15.95	2.4	2.5	6.4	114.4	1.16
MS (E_4) of SP 561609-0 mm x SP 5481-0 MM	SP 611218H07	708	4352	13.63	15.96	3.4	3.6	5.8	112.5	1.16
SP 601153H0 (SP 591101-0) mm	SP 611219H0	709	3976	12.92	15.39	2.5	2.1	5.9	117.5	0.00
MS (E_2) of SP 571702-0 mm x SP 601153H0 mm	SP 611219H01	710	4651 4	14.70	15.83	2.4	2.1	6.6	116.3	0.00
MS (E_2) of FC 501 mm x SP 601153H0 mm	SP 611219H02	711	3929	12.85	15.27	2.3	2.4	6.1	113.3	0.00
MS (E_4) of SP 561609-0 mm x SP 601153H0 mm	SP 611219H03	712	3593	11.00	16.34	3.8	3.9	5.3	116.3	0.00
MS (E_2) of SP 571702-0 mm x SL 932 MM	SP 611220H01	713	4979 1	15.48	16.08	3.4	3.3	6.0	116.3	0.00
MS (E_{2+}) of FC 501 mm x SL 932 MM	SP 611220H02	714	3978	12.86	15.47	3.0	3.3	5.3	112.1	0.00
MS (E_2) of SP 571333sl mm x SL 932 MM	SP 611220H03	715	3754	12.11	15.49	3.2	3.9	5.6	113.6	0.00
MS (E_2) of SP 581220sl mm x SL 932 MM	SP 611220H04	716	4089	12.63	16.18	3.9	4.3	5.0	113.1	0.00
MS (E_2) of SP 581194sl mm x SL 932 MM	SP 611220H06	717	4492	13.59	16.54	3.4	3.9	5.4	119.4	0.00
MS (E_4) of SP 561609-0 mm x SL 932 MM	SP 611220H07	718	4015	11.99	16.73	3.9	5.1	4.1	117.1	0.00
SP 601161H0 (SP 581813-00) MM	SP 611221H0	719	4073	12.88	15.82	2.7	2.1	6.3	112.1	0.54
MS (E_4) of SP 561609-0 mm x SP 601161H0 MM	SP 611221H01	720	4165	12.73	16.35	3.5	3.5	5.6	111.8	0.63
MS (E_3) of SP 571702-0 mm x SP 601161H0 MM	SP 611221H02	721	4889 2	15.26	16.02	2.8	2.4	6.9	110.3	0.00
NM1 (SL 122 MS mm x SP 5460-0 MM)	Acc. 2480	722	3749	12.16	15.42	3.4	3.6	5.6	114.4	0.00
M.S.C. Lot 1055 (SL 122 MS mm x SP 5460-0 MM)	Acc. 2286	723	3865	12.33	15.68	3.6	3.6	5.9	112.9	0.00
US H2 (063H1) MM	Acc. 2482	724	3455	11.36	15.21	3.6	4.7	4.6	114.4	0.00
General mean			4122.48	13.0815	15.7494				114.82	
S. E. of entry mean			123.88	0.3892	0.1215				2.200	
S. E. of entry mean as % of gen. mean			3.00	2.98	0.77				1.92	
L.S.D. (5% point)			346	1.09	0.34				6.1	

Variance Table

Source of variation	D/F	Mean square (variance): Gross sucrose	Roots	Sucrose %	Stand
Rows	7	563,150.0	4.2492	0.3431	547.75
Columns	7	408,165.9	3.4108	0.1601	18.68
Entries	23	1,325,980.7	10.7694	1.8180	47.17
Error (remainder)	154	122,761.8	1.2115	0.1181	38.71
Total	191				
Calculated F value		10.80**	8.89**	15.39**	1.22

a/ Leaf spot: 0= no leaf spot; 10= complete defoliation.

b/ Foliage vigor: Larger no. = greater vigor.

Cooperative Evaluation Tests

Seven seed lots, representing the work of several breeders, were assembled at Ft. Collins and distributed to cooperators who were to conduct evaluation tests. An eighth variety was added in all cases as a local check, and in certain observational tests additional varieties were included. The seven varieties occurring in all tests and the most generally used local check are described in an accompanying table.

Agronomic evaluation tests were conducted at the following locations by the indicated organizations: Ft. Collins, Colo. (U.S.Department of Agriculture); Ordway, Colo. (National Sugar Manufacturing Co.); Leoti, Kansas (National Sugar Manufacturing Co. and the Tribune Branch Station of Kansas Agricultural Experiment Station); Gerber and Tracy, Calif. (Holly Sugar Corp.). Tests intended primarily for evaluation of disease resistance were conducted by the U. S. Department of Agriculture at Beltsville, Md., Thatcher, Utah, and Salinas, Calif.

Results for the individual tests are presented in separate tables. Harvest results for all the agronomic tests are shown in a general summary table in which averages are given as percentages of those obtained for variety no. 1 (SL 122 MS x SP 5460-0), a monogerm hybrid serving as the standard. As shown in that table, two other monogerm hybrids were substantially above variety 1 in yield of roots and gross sucrose and were about equal to that variety in sucrose percentage. As an average of all five tests, the gross sucrose yield of variety 2 was 111 percent of that obtained for variety 1. The 4-test average gross sucrose yield for variety 4, a triploid, was 116 percent of the average for variety 1. As shown in other tables, varieties 2 and 4 were about equal to no. 1 in resistance to leaf spot and curly top.

COOPERATIVE EVALUATION TESTS OF LSR-CTR VARIETIES, 1962

Description of Varieties

Entry no.	Ft. Collins seed no.	Description and supplier
1	Acc. 2480	SL 122 MS x SP 5460-0; monogerm; LSR-CTR; seed furnished by National Sugar Mfg. Co. as no. NM1.
2	Acc. 2484	SLC 126 MS x SP 5460; monogerm; LSR-CTR; Utah-Idaho Sugar Co.
3	Acc. 2485	SL 126 MS x (110 x SP 5651); monogerm; LSR-CTR; Utah-Idaho Sugar Co.
4	Acc. 2486	SLC 128 MS x US 401 4N; monogerm; triploid; LSR-CTR; Utah-Idaho Sugar Co.
5	Acc. 2487	SLC 129 MS x SP 5460; monogerm; LSR-CTR; Utah-Idaho Sugar Co.
6	Acc. 2483	SP 5481-0; multigerm; LSR "check" (also resistant to black root); U.S.D.A., E. Lansing, Mich.
7	Acc. 2482	US H2; multigerm; CTR "check"; non-bolting; U.S. D.A., Salinas, California.
8	Acc. 2479 a/	NHM2; "local check"; monogerm; National Sugar Mfg. Co.

a/ Other material was used for local-check purposes in certain tests.

AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1962
Experiment No. 1A, Ft. Collins, Colorado

Conducted by: J. A. Elder and J. O. Gaskill

Location: Hospital Farm, Ft. Collins, Colorado; field no. 3.

Cooperation: Colorado Agricultural Experiment Station, National Sugar Manufacturing Company, Beet Sugar Development Foundation, and Board of County Commissioners of Larimer County.

Dates of Planting and Harvest: April 20-23; Oct. 1.

Experimental Design: Latin Square, 8x8; plots 4 rows x 24'; rows 20" apart; hand thinned to single-plant hills.

Determination of Root Yield: All roots in the 2 inner rows x 21' in each plot were hand topped, washed, and weighed.

Determination of Sucrose Percentage: All roots harvested for root yield determination in each plot were divided into 2 samples for sucrose analyses. Duplicate sucrose determinations were made for the composited pulp from each sample.

Stand and Bolter Counts: All hills were counted in each plot, on September 15 (±), in the area to be harvested for root yield.

Recent Cropping History: 1959 and 1960, alfalfa; 1961, barley.

Chemicals Applied for Sugarbeet Crop: Treble superphosphate (approximately 280 lbs. per acre) and ammonium nitrate (approximately 87 lbs. per acre) were applied in September, 1961, just before plowing. Shell DD (about 47 gal. per acre) was applied in September, 1961, for sugarbeet nematode control.

Leaf Spot Exposure: Severe.

Sugarbeet Nematode: Mild.

Yellows Virus: Beet yellows or western yellows was general throughout the field; effects probably mild.

Other Diseases and Pests: Negligible.

Soil and Seasonal Conditions: The weather was about normal throughout most of the growing season; drier than usual late in the season. Furrow irrigation was adequate. Inoculation and frequent sprinkling were employed in order to promote the development of leaf spot (*Cercospora beticola*).

Reliability of Test: Good.

AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1962
Experiment No. 1A, Ft. Collins, Colorado
(Results given as 8-plot averages)

Description	Ft. Col. seed no.	Entry no.	Acre Yield: Gross Sucrose	Acre Yield: Roots	Sucrose	Leaf Spot a/: 8/2	Leaf Spot a/: 8/22	b/ Vigor 8/22	Stand (hills per 100')	Bolters
			Lbs.	Tons	%				No.	%
SL 122 MS x SP 5460-0; mono.	Acc. 2480	1	3714 5	12.21 5	15.21 3	3.4	4.2	5.4	114.4	0.00
SLC 126 MS x SP 5460; mono.	Acc. 2484	2	3691 6	12.12 6	15.21 3	3.0	3.9	6.0	112.4	0.00
SL 126 MS x (110 x SP 5651); mono.	Acc. 2485	3	3679 7	12.01 7	15.32 1	3.7	4.8	5.0	117.5	0.00
SLC 128 MS x US 401 4N; mono.	Acc. 2486	4	4196 1	13.99 1	15.01 6	3.3	4.1	6.4	114.4	0.25
SLC 129 MS x SP 5460; mono.	Acc. 2487	5	3539 8	11.84 8	14.94 7	3.1	4.0	5.3	113.8	0.00
SP 5481-0; multi.; LSR check	Acc. 2483	6	3944 3	13.13 3	15.01 6	2.6	3.2	6.0	116.4	2.09
US H2; multi.; CTR check	Acc. 2482	7	4042 2	13.60 2	14.86 8	3.8	5.1	4.4	116.3	0.00
NHM2; mono.; local check	Acc. 2479	8	3732 4	12.33 4	15.14 4	4.2	5.3	4.6	114.9	0.28
General Mean			3817.20	12.6528	15.0859				114.98	
S. E. of var. mean			73.84	0.2106	0.1220				1.322	
S. E. of var. mean as % of gen. mean			1.93	1.66	0.81				1.15	
L. S. D. (5% point)			211	0.60	0.35				3.8	

Variance Table

Source of Variation	D/F	Mean Square (Variance): Gross Sucrose	Roots	Sucrose %	Stand
Rows	7	30,424.6	0.3884	0.1328	46.69
Columns	7	195,082.7	1.2329	0.4202	43.98
Varieties	7	389,147.0	5.2306	0.1992	21.66
Error (remainder)	42	43,615.4	0.3549	0.1190	13.97
Total	63				
Calculated F value		8.92**	14.74**	1.67	1.55

a/ Leaf spot: 0=no leaf spot; 10=complete defoliation.

b/ Foliage vigor: Larger no. = greater vigor.

AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1962
Ordway, Colorado

Conducted by: Loyd H. Dillon

Location: Wayne Bennett farm 1 1/2 miles west of Ordway, Colorado.

Cooperation: National Sugar Manufacturing Co.

Dates of Planting and Harvest: April 19-20; November 9-10.

Experimental Design: Latin Square, 8 x 8; plots 6 rows x 30'; rows 22" apart; hand thinned to single-plant hills.

Determination of Root Yield: All roots in the two innermost rows x 28' in each plot were topped, cleaned, and weighed.

Determination of Sucrose Percentage: All roots harvested for root yield determination in each plot were divided into 2 or 3 samples for sucrose analysis.

Stand Counts: Based on harvested roots.

Herbicides: Tillam was applied to the entire area on April 18 and disked in.

Leaf Spot Exposure: Very mild.

Curly Top Exposure: Negligible, if any.

Rhizoctonia Root Rot: Trace.

Other Diseases and Pests: Negligible.

Soil and Moisture Conditions: High fertility; adequate irrigation.

Reliability of Test: Stand at harvest was below 82 plants per 100 ft. in only 2 plots; namely, 1 plot of entry no. 4 (stand 61) and 1 plot of entry no. 5 (stand 75). Yields of roots and gross sucrose probably were depressed by poor stand in the indicated plot of entry no. 4, but the data were used without adjustment. On the whole, the results from this test are considered reliable.

AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1962
Ordway, Colorado
(Results given as 8-plot averages)

Description	Ft. Collins seed no.	Entry no.	Acre Yield: Gross Sucrose	Acre Yield: Roots	Sucrose	Stand (plants per 100')
			Lbs.	Tons	%	No.
SL 122 MS x SP 5460-0; mono.	Acc. 2480	1	6152 5	22.95 6	13.44 3	112.0
SLC 126 MS x SP 5460; mono.	Acc. 2484	2	6862 2	25.21 4	13.66 2	105.9
SL 126 MS x (110 x SP 5651); mono.	Acc. 2485	3	6593 3	25.29 3	13.03 5	107.5
SLC 128 MS x US 401 4N; mono.	Acc. 2486	4	7284 1	27.94 1	13.14 4	98.0
SLC 129 MS x SP 5460; mono.	Acc. 2487	5	5667 7	22.35 7	12.74 7	104.3
SP 5481-0; multi.; LSR check	Acc. 2483	6	6102 6	23.70 5	12.97 6	130.0
US H2; multi.; CTR check	Acc. 2482	7	6376 4	25.56 2	12.47 8	126.0
NHM2; mono.; local check	Acc. 2479	8	5478 8	19.57 8	13.97 1	127.3
General Mean			6314.08	24.0733	13.1755	113.86
S. E. of var. mean			269.98	0.9191	0.2948	5.678
S. E. of var. mean as % of gen. mean			4.28	3.82	2.24	4.99
L. S. D. (5% point)			770	2.62	0.84	16.2

Variance Table

Source of Variation	D/F	Mean Square (Variance): Gross sucrose	Roots	Sucrose %	Stand
Rows	7	1,106,634.6	28.7932	3.4920	342.02
Columns	7	975,680.6	6.5174	2.6637	75.69
Varieties	7	2,870,551.6	51.0123	1.9306	1187.12
Error (remainder)	42	583,085.9	6.7585	0.6953	257.81
Total	63				
Calculated F value		4.92**	7.55**	2.78*	4.60**

AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1962
Leoti, Kansas

Conducted by: Roy E. Gwin, Jr., and Henry Wolfe.

Location: L. A. Lambert farm, about 1 mile east of Leoti, Kansas.

Cooperation: Tribune Branch Station of the Kansas Agricultural Experiment Station, and the National Sugar Manufacturing Co.

Dates of Planting and Harvest: April 24; September 26.

Experimental Design: Latin Square, 8 x 8; plots 6 rows x 30'; rows 22" apart; hand thinned to single-plant hills. Two varieties were deleted from the test before harvest, because of poor stand.

Determination of Root Yield: With minor exceptions, all roots in 50' of row in each plot were topped, cleaned, and weighed.

Determination of Sucrose Percentage: All roots harvested for root yield determination in each plot were divided into 2 or 3 samples for sucrose analysis.

Stand Counts: Based on harvested roots.

Leaf Spot Exposure: Very mild.

Curly Top Exposure: Negligible, if any.

Rhizoctonia Root Rot: Trace.

Other Diseases and Pests: Negligible.

Soil and Moisture Conditions: Very high fertility; adequate irrigation.

Reliability of Test: Stand was rather variable in the 6 varieties harvested. However, areas of unsatisfactory stand were largely avoided in the harvesting process. It should be noted that results were estimated for 2 missing plots of entry no. 2 and for 1 missing plot, each, of entries 6 and 7. On the whole, the results from this test are considered reliable.

AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1962
Leoti, Kansas
(Results given as 8-plot averages)

Description	Ft. Collins: seed no.	Entry no.	Acre Yield: Gross sucrose	Acre Yield: Roots	Sucrose	Stand (plants per 100')
			Lbs.	Tons	%	No.
SL 122 MS x SP 5460-0; mono.	Acc. 2480	1	5208 5	23.45 6	11.10 2	126.0
SLC 126 MS x SP 5460; mono.	Acc. 2484	2 a/	5826 2	26.40 2	11.01 3	93.4
SLC 129 MS x SP 5460; mono.	Acc. 2487	5	5216 4	24.24 5	10.77 5	101.8
SP 5481-0; multi.; LSR check	Acc. 2483	6 b/	5076 6	25.04 3	10.13 6	115.5
US H2; multi.; CTR check	Acc. 2482	7 b/	6260 1	28.65 1	10.92 4	124.9
NHM2; mono.; local check	Acc. 2479	8	5515 3	24.38 4	11.31 1	128.0
General Mean			5516.77	25.3592	10.8738	114.92
S. E. of var. mean			167.99	0.6115	0.1562	4.996
S. E. of var. mean as % of gen mean			3.05	2.41	1.44	4.35
L. S. D. (5% point)			485	1.76	0.45	14.4

Variance Table

Source of Variation	D/F	Mean Square (Variance): Gross Sucrose	Roots	Sucrose %	Stand
Replications	7	319,674.0	4.7030	0.2918	142.38
Varieties	5	1,645,447.0	29.4028	1.3136	1649.48
Error (remainder)	31	225,768.4	2.9915	0.1953	199.66
Total	43				
Calculated F value		7.29**	9.83**	6.73**	8.26**

a/ The data for two plots were missing, and results for those plots were estimated, using the method of Allen and Wishart.

b/ The data for one plot were missing, and results for that plot were estimated, using the method of Allen and Wishart.

AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1962

Gerber, California

Conducted by: D. D. Dickenson

Cooperation: Holly Sugar Corporation and Dean Glatz.

Dates of Planting and Harvest: April 24; November 7.

Experimental Design: Latin Square, 8 x 8; plots 1 row x 53'; rows 30" apart; hand thinned.

Determination of Root Yield: All roots were harvested in 50' of row in each plot. Weight adjustments were made by established procedures to compensate for gaps in stand.

Determination of Sucrose Percentage: Two samples per plot; about 10-15 roots per sample.

Stand Counts: Based on harvested roots.

Diseases: Negligible.

AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1962
Gerber, California
(Results given as 8-plot averages)

Description	Ft. Col. seed no.	Entry no.	Acre Yield: Gross Sucrose	Acre Yield: Roots	Sucrose	Stand (plants per 100')
			Lbs.	Tons	%	No.
SL 122 MS x SP 5460-0; mono.	Acc. 2480	1	8663 8	32.37 8	13.41 3	159.4
SLC 126 MS x SP 5460; mono.	Acc. 2484	2	10434 1	38.67 1	13.51 2	140.1
SL 126 MS x (110 x SP 5651); mono.	Acc. 2485	3	9324 4	35.16 5	13.26 4	146.0
SLC 128 MS x US 401 4N; mono.	Acc. 2486	4	9791 2	36.13 3	13.54 1	133.8
SLC 129 MS x SP 5460; mono.	Acc. 2487	5	9522 3	36.35 2	13.12 7	141.4
SP 5481-0; multi.; LSR check	Acc. 2483	6	8816 7	33.31 7	13.25 5	160.0
US H2; multi.; CTR check	Acc. 2482	7	8863 6	33.68 6	13.16 6	151.1
NBHH1; local check		8	9040 5	35.48 4	12.75 8	157.8
General Mean			9306.52	35.1439	13.2500	148.69
S. E. of var. mean			243.66	0.8367	0.1810	4.325
S. E. of var. mean as % of gen. mean			2.62	2.38	1.37	2.91
L.S.D. (5% point)			695	2.39	0.52	12.3

Variance Table

Source of Variation	D/F	Mean Square (Variance): Gross Sucrose	Roots	Sucrose %	Stand
Rows	7	763,524.9	12.8743	1.3368	757.07
Columns	7	460,411.9	7.6684	0.3679	2054.82
Varieties	7	2,827,908.4	32.2355	0.5176	785.61
Error (remainder)	42	474,952.4	5.6000	0.2621	149.65
Total	63				
Calculated F value		5.95**	5.76**	1.97	5.25**

AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1962

Tracy, California

Conducted by: D. D. Dickenson

Cooperation: Holly Sugar Corporation and J. Paulson.

Dates of Planting and Harvest: April 30; Oct. 19.

Experimental Design: Modified Latin Square, 8 x 8; plots 1 row x 43'; rows 30" apart; hand thinned.

Determination of Root Yield: All roots were harvested in 40' of row in each plot. Weight adjustments were made by established procedures to compensate for gaps in stand.

Determination of Sucrose Percentage: Two samples per plot; about 10-15 roots per sample.

Stand Counts: Based on harvested roots.

Diseases: Negligible.

AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1962
Tracy, California
(Results given as 8-plot averages)

Description	Ft. Col. seed no.	Entry no.	Acre Yield: Gross Sucrose	Acre Yield: Roots	Sucrose	Stand (plants per 100')
			Lbs.	Tons	%	No.
SL 122 MS x SP 5460-0; mono.	Acc. 2480	1	5950 6	18.34 6	16.23 2	128.6
SLC 126 MS x SP 5460; mono.	Acc. 2484	2	6772 3	20.63 3	16.40 1	125.5
SL 126 MS x (110 x SP 5651); mono.	Acc. 2485	3	7405 1	23.03 1	16.08 5	134.5
SLC 128 MS x US 401 4N; mono.	Acc. 2486	4	7110 2	21.99 2	16.13 3	123.8
SLC 129 MS x SP 5460; mono.	Acc. 2487	5	6273 4	19.51 5	16.11 4	124.5
SP 5481-0; multi.; LSR check	Acc. 2483	6	5416 7	17.75 7	15.29 8	131.4
US H2; multi.; CTR check	Acc. 2482	7	6073 5	19.61 4	15.51 7	133.1
HH3; local check		8	5292 8	16.98 8	15.59 6	131.0
General Mean			6286.28	19.7288	15.9164	129.05
S. E. of var. mean			272.95	0.8312	0.1932	3.526
S. E. of var. mean as % of gen. mean			4.34	4.21	1.21	2.73
L. S. D. (5% point)			779	2.37	0.55	10.1

Variance Table

Source of Variation	D/F	Mean Square (Variance): Gross Sucrose	Roots	Sucrose %	Stand
Rows	7	1,307,940.1	13.2703	0.5583	154.28
Columns	7	1,541,575.3	13.8499	0.1555	354.32
Varieties	7	4,652,169.1	34.5652	1.2615	133.82
Error (remainder)	42	595,983.1	5.5278	0.2985	99.47
Total	63				
Calculated F value		7.81**	6.25**	4.23**	1.35

COOPERATIVE EVALUATION TESTS OF LSR-CTR VARIETIES, 1962
General Summary of Harvest Results for Agronomic Tests a/
(Averages expressed as percentages of those obtained for SL 122 MS x SP 5460-0)

Description	Ft. Collins seed no.	Entry no.	Gross sucrose yield: Ft. Col. b/ (1)	Gross sucrose yield: Ordway (1)	Gross sucrose yield: Leoti (2)	Gross sucrose yield: Gerber (3)	Gross sucrose yield: Tracy (3)	Root yield: Ft. Col. b/ (1)	Root yield: Ordway (1)	Root yield: Leoti (2)	Root yield: Gerber (3)	Root yield: Tracy (3)	Percent sucrose: Ft. Col. b/ (1)	Percent sucrose: Ordway (1)	Percent sucrose: Leoti (2)	Percent sucrose: Gerber (3)	Percent sucrose: Tracy (3)
SL 122 MS x SP 5460-0; mono.	Acc. 2480	1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
SLC 126 MS x SP 5460; mono.	Acc. 2484	2	99	112	112	120	114	99	110	113	119	112	100	102	99	101	101
SL 126 MS x (110 x SP 5651); mono.	Acc. 2485	3	99	107	- -	108	124	98	110	- -	109	126	101	97	- -	99	99
SLC 128 MS x US 401 4N; mono.	Acc. 2486	4	113	118	- -	113	120	115	122	- -	112	120	99	98	- -	101	99
SLC 129 MS x SP 5460; mono.	Acc. 2487	5	95	92	100	110	105	97	97	103	112	106	98	95	97	98	99
SP 5431-0; LSR check; multi.	Acc. 2483	6	106	99	97	102	91	108	103	107	103	97	99	97	91	99	94
US H2; CTR check; multi.	Acc. 2482	7	109	104	120	102	102	111	111	122	104	107	98	93	98	98	96
Local check c/	- - -	8	100	89	106	104	89	101	85	104	110	93	100	104	102	95	96
L S D (5% point)			6	13	9	8	13	5	11	8	7	13	2	6	4	4	3

a/ Location of tests: (1) Colorado; (2) Kansas; (3) California.

b/ Cercospora leaf spot was severe in the Ft. Collins test. All other tests were relatively free of diseases.

c/ Local check: NHM2 in Colorado and Kansas tests; NBHH1 (L196) at Gerber, California; and HH3 (L013) at Tracy, California.

OBSERVATIONAL TEST OF LSR-CTR VARIETIES, 1962
Beltsville, Maryland
Test conducted by G. E. Coe, U.S.D.A.
(Results given as 2-plot averages) a/

Description	Ft. Collins seed no.	Entry no.	Roots b/ per acre	Leaf spot c/ 8/1	Leaf spot c/ 8/6	Leaf spot c/ 8/14	Fol. d/ vigor 7/11
			Tons				
SL 122 MS x SP 5460-0; mono.	Acc. 2480	1	13.64 3	4.4	5.0	5.0	3.9
SLC 126 MS x SP 5460; mono.	Acc. 2484	2	14.55 2	4.3	4.6	5.0	3.4
SL 126 MS x (110 x SP 5651); mono.	Acc. 2485	3	12.48 6	4.4	4.8	4.5	2.5
SLC 128 MS x US 401 4N; mono.	Acc. 2486	4	13.45 4	4.0	4.9	5.0	3.3
SLC 129 MS x SP 5460; mono.	Acc. 2487	5	12.65 5	3.9	4.3	4.5	3.1
SP 5481-0; multi.; LSR check	Acc. 2483	6	15.86 1	3.3	3.6	4.3	2.8
US H2; multi.; CTR check	Acc. 2482	7	11.92 8	4.4	4.9	5.0	2.1
NHM2; mono.	Acc. 2479	8	11.98 7	4.5	5.1	5.3	2.4
Synthetic Check (European)	Acc. 2269	-	- -	5.0	5.8	5.5	2.0

a/ Plots 4 rows x 20'; rows 24" apart.

b/ Root yield for each plot based on the 2 inner rows.

c/ Basis of leaf spot readings: 0= none; 10= complete defoliation.

d/ Foliage vigor: Higher no. = greater vigor.

OBSERVATIONAL TEST OF LSR-CTR VARIETIES, 1962
Thatcher, Utah

Test Conducted by Albert M. Murphy, U.S.D.A.

Description	Ft.Collins seed no.	Entry no.	Thinned a/ stand (no.)	Curly a/ top (%)	Curly top grade a/	
			Section I			
			7/28	8/24	9/13	9/27
SL 122 MS x SP 5460-0; mono.	Acc. 2480	1	81	55.6	5	
SLC 126 MS x SP 5460; mono.	Acc. 2484	2	93	54.8	4	
SL 126 MS x (110 x SP 5651); mono.	Acc. 2485	3	77	58.4	5	
SLC 128 MS x US 401 4N; mono.	Acc. 2486	4	81	63.0	5	
US 33 (check)			91	83.5		7
			Section II			
			7/27	8/30	9/13	9/27
SLC 129 MS x SP 5460; mono.	Acc. 2487	5	69	100.0	7	
SP 5481-0; multi.; LSR check	Acc. 2483	6	100	100.0	8	
US H2; multi.; CTR check	Acc. 2482	7	93	54.8	4	
NHM2; mono.	Acc. 2479	8	98	32.7	4	
US 33 (check)			90	63.3		6

a/ Results based on a single plot (2 rows x 50') for each entry. Basis of curly top grades: 0= healthy; 9= death due to curly top

Note: The crop was planted on June 12, and severe curly top exposure was promoted by artificial means.

GREENHOUSE TEST OF LSR-CTR VARIETIES FOR CURLY TOP RESISTANCE, 1962
Salinas, California

Test Conducted by C. W. Bennett, U.S.D.A.

Description	Ft. Collins seed no.	Entry no.	Curly top isolate & aver. grade of severity a/ Strain 11 Prelim.	Strain 11 Final (5/25)	Los Banos Prelim.	Los Banos Final (5/25)
SL 122 MS x SP 5460-0; mono.	Acc. 2480	1	3.8	3.75	4.2	4.83
SLC 126 MS x SP 5460; mono.	Acc. 2484	2	4.0	3.97	4.3	4.97
SL 126 MS x (110 x SP 5651); mono.	Acc. 2485	3	3.4	3.21	4.2	4.72
SLC 128 MS x US 401 4N; mono.	Acc. 2486	4	3.7	3.53	4.6	4.97
SLC 129 MS x SP 5460; mono.	Acc. 2487	5	3.8	4.19	4.7	5.04
SP 5481-0; multi.; LSR check	Acc. 2483	6	4.1	4.19	4.9	5.09
US H2; multi.; CTR check	Acc. 2482	7	3.6	3.42	4.0	4.01
NHM2; mono.	Acc. 2479	8	4.0	3.64	4.5	4.97
US 75; multi.			3.8	3.86	4.4	4.97

a/ Infected living plants were graded from 1 to 5 in ascending order of severity. In the computation of averages, dead plants were classed as grade 5 and non-infected individuals were disregarded.

Note: Forty young seedlings of each variety were inoculated on April 9(20 with curly top strain 11 and 20 with the Los Banos isolate). Not more than 4 individuals failed to become infected in any one 20-plant set.

PART VI

DEVELOPMENT OF BREEDING PROCEDURES
and
PRODUCTION OF BASIC BREEDING MATERIAL

Chemical Genetic Studies
and
Polyploidy Evaluation

Foundation Project 25

LeRoy Powers R. J. Hecker

Research conducted in cooperation with Colorado Agricultural Experiment Station.

PROGRESS REPORT TO THE BEET SUGAR DEVELOPMENT FOUNDATION ON THE GENETIC AND PLANT BREEDING PHASES OF PROJECT NUMBER 25 1/

By LeRoy Powers and Richard J. Hecker

Plant Breeding Studies Involving Eight Characters

The primary purposes of the investigations are to obtain information as follows: effectiveness of different methods of breeding sugar beets, comparative merits of different populations available for use in breeding programs, shifts in the means and in the associations of the eight characters as affected by breeding methods, and the magnitude of the means and the association of the eight characters in materials available to the plant breeder. The primary purposes if accomplished would provide some information on specific and general combining ability. Hence, a most important purpose of the study was to learn something about specific and general combining ability as regards the eight characters studied.

At this time it seems desirable and appropriate to point out that the breeding methods studied are extremely limited and that the report on those that are included in the study must be considered as limited in scope and as preliminary. Further, the genotypes as represented by the populations are again a small sample of those present in sugar beets and its relatives. Hence, the drawing of sweeping general conclusions as to methods of breeding, materials, or associations of characters is not justified. However, as the research progresses and more breeding methods, more genotypes and more diverse environments are included, more general conclusions will be justified.

Materials and Methods

The materials studied consist of inbreds, varieties, and hybrids. The methods of breeding studied consist of mass selection from small units and recurrent selection within the progeny of the original individual plant selection 4W-34 having the best performance record for both weight per root and percentage sucrose. The seed from this outstanding selection 4W-34 was produced in a polycross isolation plot, and it was from the population produced from this seed that the simple recurrent selections were made. The material consists of 19 different populations. A study of the means of the eight characters of these 19 different populations provides the information presented in this report.

1/ The breeding and genetic phases of project 25 are cooperative with the Agronomy and Chemistry Departments of the Colorado State University Agricultural Experiment Station.

The populations employed in the study are as follows. CMS BB_1 is a population of sugar beets derived from cytoplasmic male sterile plants (S. L. 211-H3) exposed to pollen from 20 different populations. By using 20 different pollen parents it was hoped to obtain a population having a broad genetic base. BB_1 designates the population grown from the first seed increase of this broad based material.

Population 4W-34 is from an individual plant selection of A54-1. This individual plant selection was increased by asexual reproduction to produce population 4W-34. Population 4W-34 S_2 is 4W-34 inbred for two generations. Population 4W-34AR was derived from seven roots selected from the progeny of 4W-34 grown in polycross test trials. These progeny in turn were produced from seed of 4W-34 grown in a polycross isolation plot with 31 other individual plant selections from A54-1. These 32 roots from A54-1 were selected for high weight per root and high percentage sucrose.

A54-1 is a commercial variety which was grown for several years in the Great Plains Region east of the Rocky Mountains. A56-3 is a seed increase of A54-1 made by the Great Western Sugar Company in Oregon. Populations 52-430, 54-520, 52-307, 52-305, and 34 are inbreds produced by self pollination. Population A58-5 is a stock beet and A58-22 is SP 5832-0 which possesses considerable resistance to the organisms causing leaf spot and root rot.

To produce the hybrids with CMS BB_1 having 4W-34, A54-1, 4W-34 S_2, and 4W-34 AR as pollen parents, 40 roots of CMS BB_1 were quartered and one quarter was planted in each of four different isolation plots to produce the four topcross populations. The procedure was the same for the four topcross hybrids having 34, A54-1, A58-5, and A58-22 as pollen parents.

Of the CMS BB_1 population, 34 percent (27 plants among 80) of the progeny were cytoplasmic male-sterile plants. The pollen producers among the 40 CMS BB_1 plants used to produce each of the two groups of hybrids were pulled and discarded before pollen was shed. This assured that the seed harvested from the cytoplasmic male-sterile plants resulted from cross fertilization.

The design of the experiment was a modified randomized complete block. There were two groups of populations, each composed of 12 entries. The populations were randomized within groups and replications and the groups were randomized within replications. Hence, for each of the two groups of populations taken individually the design of the experiment was a randomized complete block. There are 30 replications.

Results

The results will be presented under the characters studied and under groups 1 and 2.

As pointed out under "Materials and Methods" A54-1 and A56-3 are different seed increases of the same variety and the increases were made by the Great Western Sugar Company in Oregon. A study of table 1 reveals that the differences between the populations resulting from these seed increases are not statistically significant for weight per root nor for any of the other seven characters. This finding holds for both groups 1 and 2. All of the data presented in this article are listed in table 1.

Table 1 Means and their standard errors for weight per root, percentage sucrose, percentage apparent purity, total nitrogen, betaine, glutamic acid, sodium, and potassium; the latter 5 expressed as milligrams per 100 milliliters of thin juice equated to a refractometer reading of 10; 1960.

Group, population, and entry number	Weight	Sucrose	Purity	Total nitrogen	Betaine	Glutamic acid	Sodium	Potassium
	Kg.	%	%	Mg/100ml	Mg/100ml	Mg/100ml	Mg/100ml	Mg/100ml
Group 1								
CMS BB_1 X 4W-34, 1	1.17±0.030	16.7±0.19	92.2±0.26	53.1±1.82	133.30±1.847	79.67±4.555	28.03±2.480	57.21±1.836
CMS BB_1 X A54-1, 2	1.19±0.028	16.5±0.16	91.5±0.29	54.1±1.89	132.14±1.823	77.84±4.619	29.57±2.010	61.94±1.918
A54-1, 3, check	1.12±0.031	16.9±0.18	91.9±0.26	47.5±1.94	136.70±2.267	65.04±4.906	29.20±2.190	59.33±2.165
CMS BB_1 X 4W-34 S_2, 4	1.09±0.026	17.2±0.13	92.3±0.27	51.5±1.65	132.18±1.364	79.19±4.527	25.04±2.044	56.33±1.851
4W-34 S_2, 5	0.92±0.026	17.0±0.16	91.6±0.27	51.7±1.86	140.05±2.345	78.18±4.341	26.72±2.007	53.78±1.608
CMS BB_1 X 4W-34AR, 6	1.14±0.025	16.9±0.18	92.1±0.26	49.9±1.92	129.77±1.977	71.00±3.788	25.70±1.890	53.65±1.202
4W-34AR, 7	0.98±0.021	17.4±0.15	92.7±0.21	45.1±1.21	140.12±1.795	49.61±2.477	23.41±1.598	53.93±1.916
52-430 X 54-520 F_1, 8	1.08±0.020	17.1±0.14	90.7±0.22	60.0±2.53	147.16±2.342	108.14±6.481	25.31±1.700	72.61±2.339
52-430 X 52-307 F_1, 9	1.21±0.025	17.8±0.14	92.9±0.20	40.2±1.05	151.32±2.701	38.57±2.772	22.14±1.538	58.88±1.726
54-520 X 52-305 F_1, 10	1.09±0.032	16.9±0.16	89.6±0.34	67.8±2.71	168.87±2.914	118.94±6.634	21.67±1.723	78.60±2.567
A56-3, 11, check	1.09±0.028	16.9±0.19	91.6±0.32	52.3±2.35	138.17±2.402	73.81±6.338	31.43±2.298	59.82±2.054
54-520, 12	0.83±0.019	16.2±0.16	88.6±0.34	75.2±2.45	160.33±3.366	141.75±6.072	30.10±1.849	70.20±2.382
Group 2								
CMS BB_1 X 34, 13	1.32±0.027	16.3±0.18	92.2±0.31	47.2±2.45	116.41±2.204	63.34±4.985	31.69±2.911	56.83±2.150
34, 14	0.69±0.017	16.4±0.21	91.4±0.31	49.5±2.12	130.89±2.301	69.72±5.159	27.45±2.696	51.96±2.066
CMS BB_1 X A54-1, 15	1.23±0.034	16.0±0.17	91.4±0.27	50.6±2.04	138.07±2.495	70.68±4.101	32.74±2.219	68.91±2.485
A54-1, 16, check	1.18±0.026	16.6±0.17	91.6±0.26	51.3±1.91	146.35±2.926	74.35±5.089	31.75±2.128	65 47±2.319
CMS BB_1 X A58-5, 17	1.67±0.049	12.6±0.18	87.9±0.32	64.0±2.25	148.84±2.347	110.06±5.077	56.65±3.401	99.89±2.298
A58-5, 18	1.75±0.062	9.1±0.18	82.0±0.54	77.8±2.33	171.80±4.569	130.01±5.079	84.89±4.311	129.74±3.590
CMS BB_1 X A58-22, 19	1.24±0.031	15.7±0.18	91.4±0.27	50.4±2.05	132.70±1.979	65.27±3.557	37.04±2.760	66.53±1.887
A58-22, 20	1.10±0.027	15.5±0.20	91.2±0.33	47.8±1.98	145.11±2.816	53.35±3.150	39.98±3.255	61.94±1.683
52-430 X 54-520 F_1, 21	1.11±0.029	16.8±0.20	90.4±0.32	63.6±2.45	151.82±2.352	117.83±5.512	30.01±2.099	76.50±2.278
54-520 X 52-305 F_1, 22	1.09±0.021	16.7±0.15	89.1±0.35	71.7±2.15	173.37±3.487	124.78±4.831	25.80±1.927	80.43±3.037
A56-3, 23, check	1.15±0.028	16.8±0.13	91.6±0.27	51.5±1.64	140.40±2.328	72.33±4.753	31.66±2.460	59.90±2.146
54-520, 24	0.89±0.025	15.9±0.15	88.5±0.36	74.9±2.91	160.07±3.308	148.57±6.861	33.46±3.845	69.57±2.401

Weight per root

Group 1

In group 1 the lower weights per root are found in those populations where some degree of inbreeding has been practiced, namely 4W-34 S_2, 4W-34AR, and inbred 54-520. The lowest yield is for the inbred 54-520. The root weights for 4W-34AR (0.98 kg), 4W-34S_2 (0.92 kg), and 54-520 (0.83 kg) are closely associated with the degree of inbreeding. However, the difference between 4W-34AR and 4W-34 S_2 is not significant at the 5-percent level. The low yields of these inbred populations are not closely associated, either positively or negatively, with any of the other seven characters. For example, 54-520 is lower in percentage sucrose and percentage apparent purity and higher in all the other characters; whereas 4W-34AR and 4W-34 S_2 are the reverse. Further, 52-430 X 52-307 has the highest weight per root, percentage sucrose, and percentage apparent purity and is lower than these inbred populations in all the other characters excepting concentrations of betaine and potassium. It is higher than 4W-34 S_2 and 4W-34AR in concentrations of betaine and potassium.

Of the four populations topcrossed with CMS BB_1, only A54-1 and 4W-34 S_2 produced hybrids differing significantly in weight per root. The increase of CMS BB_1 X A54-1 over CMS BB_1 X 4W-34 S_2 is 9 percent. These topcross hybrids did not differ significantly for any of the other seven characters, with the possible exception of percentage sucrose, percentage apparent purity, and concentration of potassium. The differences in percentage sucrose and percentage apparent purity for the topcrosses CMS BB_1 X A54-1 and CMS BB_1 X 4W-34 S_2 are significant at the 1-percent level and the 5-percent level, respectively. The differences are in favor of CMS BB_1 X 4W-34 S_2. The lower values for CMS BB_1 X A54-1 cannot be attributed, logically, to the root weight, 1.19 kg as compared with 1.09 kg, because 52-430 X 52-307 F_1 has a root weight of 1.21 kg and is significantly higher in both percentage sucrose and percentage apparent purity than is CMS BB_1 X A54-1. It is interesting to note that none of the CMS BB_1 topcross hybrids in group 1 differ significantly in any of the chemical characters other than sucrose and concentration of potassium. Low concentration of potassium in these topcross hybrids is associated with high percentage sucrose and high percentage apparent purity. CMS BB_1 X A54-1 is higher in concentration of potassium and lower in sucrose and purity.

Of the F_1 hybrids between inbreds only 52-430 X 52-307 exceeded the checks (A54-1 and A56-3) in weight per root, percentage sucrose, and percentage apparent purity. The increase in weight per root is 9 percent.

In group 1 weight per root is not closely associated, either positively or negatively, with any of the other seven characters.

Group 2

In group 2 the lowest weights per root are for the inbreds 34 and 54-520 and the highest weights per root are for the stock beet (A58-5) and its topcross hybrid with CMS BB_1. The CMS BB_1 topcross hybrid with inbred 34 gave significantly higher weight per root than the topcross hybrid with the commercial variety (A54-1). The F_1 hybrids between inbreds do not differ significantly for weight per root but are lower in weight per root than the commercial checks and about the same in this respect as A58-22. A58-22 is lower in weight per root than its hybrid with CMS BB_1. Its hybrid with CMS BB_1 is equal to CMS BB_1 X A54-1 and superior to A54-1 (the check) in weight per root.

For group 2 there is an association between weight per root and the other seven characters. The CMS BB_1 hybrids having 34, A54-1, and A58-22 as pollen parents are lower in weight per root but higher in percentage sucrose and percentage apparent purity than the stock beet (A58-5) and the CMS BB_1 hybrid with the stock beet. These differences are marked. However, to attribute the lower sucroses and purities to higher yields would not be justified for the following reasons. CMS BB_1 X A58-5 has a weight per root that is not statistically significantly lower than that of A58-5, but sucrose is 3.5 percent higher and purity is 5.9 percent higher for the topcross. Again CMS BB_1 X 34 has approximately the same percentage sucrose as CMS BB_1 X A54-1, but it is significantly higher in percentage apparent purity. Since CMS BB_1 X A58-5 is considerably below the better hybrids and commercial varieties in both sucrose and purity, it would be equally as erroneous to conclude that the evidence substantiates the conclusion that the high weight per root of the stock beet can be combined with the higher percentage sucrose and percentage apparent purity of the better hybrids and varieties. Further genetic and breeding studies are necessary to determine whether such is the case.

For group 2 the relations between weight per root, total nitrogen, betaine, and glutamic acid are striking for certain comparisons. These are the ones in which CMS BB_1 X A58-5, A58-5, 54-520 and the two F_1 hybrids having 54-520 as one parent are compared with the other populations. All of those populations listed immediately above are higher in total nitrogen, betaine, and glutamic acid than are populations CMS BB_1 X 34, 34, CMS BB_1 X A54-1, CMS BB_1 X A58-22, A58-22, and the checks (A54-1 and A56-3). However, in a few cases the differences involving betaine are not statistically significant. It will be remembered that A56-3 is a seed increase of A54-1 made in Oregon. CMS BB_1 X A58-5 and A58-5, which are higher in the nitrogenous characters are also higher in weight per root, as compared with the populations listed above. On the other hand, 52-430

X 54-520 F_1, 52-520 X 52-305 F_1 and 54-520 are likewise higher in the three nitrogenous characters and are lower in weight per root than these same seven populations. From the immediately above considerations and a study of the data under group 2 of table 1 it is apparent that both the lower weights per root and the higher weights per root are found among those populations highest in concentrations of total nitrogen, betaine, and glutamic acid in the thin juice. CMS BB_1 X 34 is not materially different from CMS BB_1 X A54-1 in total nitrogen in the thin juice, but it is significantly lower in betaine and glutamic acid and higher in weight per root. The results from these studies support the conclusion that weight per root and milligrams per 100 milliliters of thin juice, of total nitrogen, betaine and glutamic acid can be recombined or retained in desirable combinations during the breeding program. The degree to which high weight per root and low concentration of the nitrogenous characters can be recombined is not shown by these data, because the two populations (CMS BB_1 X A58-5 and A58-5) having the highest weights per root also had the higher concentrations of these nitrogenous characters in the thin juice.

For the organic salts, sodium and potassium, the highest weights per root are found in the two populations (CMS BB_1 X A58-5 and A58-5) having the highest concentrations of these two elements. However, for potassium (k) this relation does not necessarily hold for comparison between the populations after CMS BB_1 X A58-5 and A58-5 have been excluded. For example, 54-520 X 52-305 F_1 has a root weight of 1.09 kilograms and k concentration of 80.43 milligrams per 100 milliliters of thin juice, whereas CMS BB_1 X 34 has a weight per root of 1.32 kilograms and k concentration of 56.83 milligrams per 100 milliliters

Percentage sucrose

Group 1

Comparisons between populations in group 1 for percentage sucrose reveal the following: The F_1 hybrid 52-430 X 52-307 is highest in percentage sucrose, being significantly higher than the commercial checks. With the possible exception of CMS BB_1 X 4W-34 S_2 (17.2%) compared with CMS BB_1 X A54-1 (16.5%), the CMS BB_1 hybrids do not differ significantly in percentage sucrose. It is interesting to note that 54-520 is lowest (16.2%) in percentage sucrose, yet its F_1 hybrids are as high in this respect as is the commercial check.

For group 1 the three populations having the highest percentage sucrose have the highest percentage apparent purity. These are 52-430 X 52-307, 4W-34AR, and CMS BB_1 X 4W-34 S_2 and the values for sucrose and purity, respectively, are 17.8% and 92.9%, 17.4% and 92.7%, and 17.2% and 92.3%. The population 54-520 having the lowest percentage sucrose also has the lowest percentage apparent purity, the values being 16.2% and 88.6%, respectively. That sucrose and purity are not necessarily positively associated is shown by comparing CMS BB_1 X 4W-34 (16.7% sucrose and 92.2% purity) with 54-520 X 52-305 (16.9% sucrose and 89.6% purity). The percentages of sucrose are not materially different, but the percentages purity are significantly different at the 5% level. The comparison involving CMS BB_1 X 34 and 52-430 X 54-520 F_1 leads to the same conclusion with the difference in percentage sucrose approaching statistical significance at the 5% level rather closely. The positive association between percentage sucrose and percentage purity facilitates breeding hybrids and varieties excelling in both characters, but is not sufficiently close to justify not analyzing for both characters in a breeding program.

Considering the associations between percentage sucrose and the nitrogenous characters, 52-430 X 52-307 F_1 is highest in sucrose (17.8%), the lowest in total nitrogen (40.2 mg/100ml) and glutamic acid (38.57 mg/100ml), but the third highest (151.32 mg/100ml) in betaine. Population 54-520 is lowest (16.2%) in sucrose, highest (75.2 mg/100ml) in total nitrogen and glutamic acid (141.75 mg/100ml), and second highest (160.33 mg/100ml) in betaine. Population 54-520 X 52-305 F_1 has the same (16.9%) sucrose content as A54-1 but is materially higher (67.8 mg/100ml and 47.5 mg/100ml, 168.87 mg/100ml and 136.70 mg/100ml, and 118.94 mg/100ml and 65.04 mg/100ml, respectively) in concentrations of total nitrogen, betaine, and glutamic acid. Hence at least to some extent percentage sucrose and these nitrogenous characters can be recombined.

Sucrose is not very closely associated with either concentration of sodium or potassium in the thin juice.

Group 2

In group 2 the populations having the highest percentage sucrose are the commercial check and the F_1 hybrids. The lowest percentages sucrose are for the stock beet A58-5 and its topcross hybrid.

In group 2 there is a rather high positive association between percentage sucrose and purity due to the inclusion in the studies of the stock beet (A58-5) and its hybrid with CMS BB_1. The values for these two populations compared with A54-1 are 9.1% and 82.0%, 12.6% and 87.9%, and

16.6% and 91.6%, respectively. Excluding these two populations, the associations between sucrose and purity are inconsistent. For example, considering the populations A58-22, 54-520 X 52-305 F_1, A56-3, and 54-520 the values are 15.5% and 91.2%, 16.7% and 89.1%, 16.8% and 91.6%, and 15.9% and 88.5%. Again the conclusion is reached that in a breeding program it is desirable in order to breed high quality beets to analyze for both percentage sucrose and percentage apparent purity.

Essentially the same conclusions can be drawn for the associations between percentage sucrose and the nitrogenous characters as was drawn for sucrose and purity. Also, the same holds for sodium and potassium.

Percentage apparent purity

Group 1

As was the case for weight per root and percentage sucrose the F_1 hybrid 52-430 X 52-307 has the highest percentage apparent purity, being significantly higher than the commercial checks. The inbred 54-520 is lowest in all three characters. For percentage purity this inbred was significantly lower at the 5% level than any other population. The same is true of its F_1 hybrids.

Comparisons involving the CMS BB_1 hybrids and their pollen parents are interesting. The parent 4W-34AR has the highest (92.7%) percentage purity, being significantly higher than the material from which it was derived, namely A54-1 (91.9%). Also it was significantly higher than its maternal parent self fertilized twice (4W-34S_2, 91.6%). Comparing the CMS BB_1 hybrids populations CMS BB_1 X 4W-34AR (92.1%), CMS BB_1 X 4W-34 S_2 (92.3%), CMS BB_1 X 4W-34 (92.2%), and CMS BB_1 X A54-1 (91.5%), it is apparent that 4W-34AR, 4W-34 S_2, and 4W-34 gave higher combining ability for percentage purity than did A54-1, the material from which they were selected by individual plant selection and simple recurrent selection. It will be recalled that selection was for weight per root and percentage sucrose and not for percentage apparent purity.

There are high degrees of association between percentage apparent purity and concentrations of total nitrogen and glutamic acid in the thin juice. The associations are negative. Population 52-430 X 52-307 F_1 is the highest of all varieties in apparent purity and lowest in concentrations of total nitrogen and glutamic acid. Population 54-520 is lowest in purity and highest in concentrations of both total nitrogen and glutamic acid. Other comparisons involving the associations between purity and concentrations of total nitrogen and glutamic acid confirm this close negative association. For example, the CMS BB_1 topcross hybrids

are intermediately high in purity and intermediately low in concentrations of total nitrogen and glutamic acid. The association between percentage apparent purity and concentration of betaine is not nearly so marked. Population 52-430 X 52-307 F_1 is highest in purity and third highest in concentration of betaine. A study of the data in table 1 reveals that in general the association between purity and betaine is negative, but the relation is not marked.

The associations between percentage purity and concentration of sodium and this same character and concentration of potassium are negative. The associations are not close.

These data indicate that it will be very difficult to recombine high percentage apparent purity with either a high concentration of total nitrogen or a high concentration of glutamic acid. It would not be so difficult to recombine higher percentages apparent purity with higher concentrations of betaine if there were any reasons for so doing.

Group 2

In group 2 the highest purities are found for the checks (A54-1 and A56-3), inbred 34, and the CMS BB_1 topcrosses with them. The lowest purities are for A58-5, 54-520, and CMS BB_1 X A58-5.

As for group 1, percentage purity in group 2 is closely associated with total nitrogen and glutamic acid. Due largely to the inclusion of the stock beet A58-5 and its topcross hybrid, purity is rather closely associated with concentration of betaine. The relations are negative. Also percentage apparent purity is rather closely associated with concentration of potassium in the thin juice. The association with sodium is not so close. In both cases the relation is negative.

Total nitrogen, betaine, and glutamic acid

The concentrations of total nitrogen, betaine, and glutamic acid will be considered together. They are expressed as milligrams per 100 milliliters of thin juice equated to a refractometer reading of 10.

Group 1

The lowest concentration of total nitrogen is for the F_1 hybrid 52-430 X 52-307. The highest concentrations of total nitrogen are for the inbred 54-520 and its F_1 hybrids. There are no material differences between the topcross hybrids involving CMS BB_1 as the tester. Further there are no material differences in concentrations of total nitrogen between A54-1 and its derivatives, 4W-34 S_2 and 4W-34AR. It will be remembered that the derivatives were selected for high weight per root and high percentage sucrose. To a great extent the findings for total nitrogen hold for glutamic acid. This is not as true for betaine. For example 54-430 X 52-307 F_1 is lowest of all populations in total nitrogen and third highest in betaine. Also CMS BB_1 X 4W-34, CMS BB_1 X A54-1, CMS BB_1 X 4W-34 S_2, and CMS BB_1 X 4W-34AR are intermediate in total nitrogen and lowest in betaine.

The association between total nitrogen and glutamic acid is very strong, whereas that with total nitrogen and betaine is not nearly so marked. The relation is positive. The associations of total nitrogen, glutamic acid, and betaine in the thin juice with sodium are not close. The associations of these same nitrogenous characters with potassium are much closer.

Group 2

In group 2 the lowest concentrations of total nitrogen, betaine, and glutamic acid are for the CMS BB_1 topcross hybrids and their pollen parents, excluding CMS BB_1 X A58-5 and excluding A58-5. For total nitrogen and glutamic acid the differences between these populations are not statistically significant with the possible exception of A58-22 for glutamic acid. Population A58-22 is lowest of all populations in concentration of glutamic acid. However, statistically significant differences do exist between these populations as regards betaine. The highest concentrations of total nitrogen, betaine, and glutamic acid are for populations A58-5, 54-520, and 54-520 X 52-305 F_1. The differences in concentrations of these three chemical characters between these last three populations are not statistically significant.

The positive associations involving total nitrogen, betaine, and glutamic acid are very close for the populations of group 2. The associations between these three nitrogenous characters and sodium show positive and significant relations, because the nitrogenous characters for populations A58-5 and CMS BB_1 X A58-5 also have extremely high concentrations of sodium. The same findings hold for potassium.

Sodium and potassium

Group 1

The populations highest in sodium are 54-520, the checks, CMS BB_1 X 4W-34, and CMS BB_1 X A54-1. The populations lowest in sodium are 54-520 X 52-305 F_1, 52-430 X 52-307 F_1, and 4W-34AR. All the differences in sodium are small for group 1, comparatively speaking, and are of questionable statistical significance. Populations 54-520 and the F_1 hybrids having this inbred as one parent are high in concentrations of potassium. Populations 4W-34 S_2 and 4W-34AR are significantly lower in potassium than A54-1, the populations from which they were derived. Likewise, the topcross hybrids of these two selections with CMS BB_1 are significantly lower in potassium than the topcross hybrid of A54-1 with CMS BB_1. Further, the topcross hybrid CMS BB_1 X 4W-34 is lower in concentration of potassium than is CMS BB_1 X A54-1.

The association between sodium and potassium for group 1 is slight.

Group 2

The populations in group 2 highest in concentrations of sodium are A58-5 (84.89 mg/100ml) and CMS BB_1 X A58-5 (56.65 mg/100ml). The populations lowest in concentrations of sodium are 54-520 X 52-305 F_1 (25.80 mg/100ml) and 34 (27.45 mg/100ml). Populations A58-5 and CMS BB_1 X A58-5 are also highest in concentrations of potassium (129.74 mg/100ml and 99.89 mg/100ml, respectively). The lowest in concentration of potassium is 34 (51.96 mg/100ml) and the next lowest is this inbred topcrossed with CMS BB_1 (56.83 mg/100ml). Due to populations A58-5 and CMS BB_1 X A58-5 there is a positive association between sodium and potassium. However, excluding these two populations 54-520 X 52-305 F_1 is the lowest in sodium and highest in potassium.

Discussion and Conclusions

Thirty-two individual plant selections were made from A54-1 grown in small units. They were selected from a potential of 11,520 plants from a plot in which the stand remained excellent throughout the growing season. The progeny of one of these 32 plants grown in a polycross test appeared outstanding in both yield and percentage sucrose. Subsequently this plant was increased by asexual propagation (4W-34), was self-

pollinated for two generations (4W-34 S_2), and 7 individual plant selections (4W-34AR) were made from the progeny grown in the polycross test. These 7 plants were selected from the progeny of 4W-34 on the basis of high weight per root and high percentage sucrose. Population 4W-34AR, as well as population 4W-34 S_2, has had some degree of inbreeding. This is true for 4W-34AR because the 7 plants composing this population had 4W-34 as the maternal parent. Any of the 32 plants in the polycross isolation plot could have served as the pollen parent.

The topcrosses with CMS BB_1 involving 4W-34, its two derivatives and A54-1 provide information as to the general combining ability of an individual plant selection that in a polycross test appeared to be genetically superior, and information on the general combining ability of derivatives obtained by self fertilization and one cycle of simple recurrent selection.

Both 4W-34 S_2 and 4W-34AR were inferior in weight per plot to A54-1, the material from which they were derived. Since these are inbred to some degree this was to be expected. Population 4W-34 S_2 was also inferior in general combining ability for weight per root and 4W-34 and 4W-34AR were lower than A54-1 in general combining ability, but the difference is not statistically significant.

Population 4W-34 S_2 is not significantly different from A54-1 in either percentage sucrose or percentage apparent purity. However, it is superior to A54-1 in general combining ability for both percentage sucrose and percentage apparent purity in which CMS BB_1 is used as the topcross tester. The differences are significant at the 5-percent level.

As regards concentrations of total nitrogen, betaine, and glutamic acid 4W-34 S_2 is higher in all three than A54-1, but taken individually, none of the differences are significant at the 5-percent level. In the topcross test 4W-34 S_2 does not differ materially compared with A54-1 in concentrations of total nitrogen, betaine, or glutamic acid. Hence there has been no improvement in 4W-34 S_2 itself or in its general combining ability as regards the three nitrogenous characters.

Population 4W-34 S_2 has lower concentrations of both sodium and potassium than does A54-1. This is also true of its topcross hybrid compared with the topcross hybrid of A54-1. However, taken individually none of the differences are statistically significant at the 5-percent level. From the data taken collectively it would appear that there may have been some improvement for sodium and potassium concentrations in 4W-34 S_2 itself and in its general combining ability as compared with A54-1.

It will be remembered that the selection of 4W-34 was based on the phenotype, weight per root and percentage sucrose, of the original root and the behavior of its progeny as regards these two characters in a polycross test. Hence the method of selection accompanied by inbreeding to produce 4W-34 S_2 has resulted in both a reduction in weight per root and a reduction in general combining ability for weight per root. There have been no changes in percentage sucrose and percentage apparent purity, but this method of selection has resulted in an increase in general combining ability for these two characters. This method of selection for weight per root and percentage sucrose has not resulted in any material changes in 4W-34 S_2 or its general combining ability for concentrations in the thin juice of total nitrogen, betaine, and glutamic acid. It seems that there have been decreases in both sodium and potassium in 4W-34 S_2 and an improvement in its general combining ability for these two characters.

Turning to a consideration of the completion of the first cycle of simple recurrent selection as represented by the seven plants of 4W-34AR it is apparent, as compared with A54-1, there have been a reduction in weight per root, increases in both percentage sucrose and percentage apparent purity, no material changes in concentrations of total nitrogen and betaine, a statistically significant decrease in glutamic acid, and probable decreases in the concentrations of both sodium and potassium. Taken individually the conclusions for sodium and potassium are not well established statistically.

General combining ability for 4W-34AR is shown by comparing the top-crosses CMS BB_1 X 4W-34AR and CMS BB_1 X A54-1. Population 4W-34AR has lower general combining ability for weight per root. However, this is not well established statistically. Population 4W-34AR shows superior combining ability for all other characters if increases in percentage sucrose and percentage apparent purity are considered desirable and decreases in all other characters as desirable. These conclusions concerning general combining ability are fairly well established statistically for percentage sucrose, percentage apparent purity and concentration of potassium. Taken individually they are not well established for concentrations of total nitrogen, betaine, glutamic acid or sodium.

Turning to a consideration of specific combining ability in group 1, the F_1 hybrid (52-430 X 52-307) as compared with the checks (A54-1 and A56-3) represents an improvement in all characters except concentrations of betaine and potassium. This F_1 hybrid is not significantly different from the checks in concentration of potassium but is significantly higher than the checks in concentration of betaine. The other two F_1 hybrids are not materially different from the checks in weight per root and percentage sucrose but are materially lower in percentage apparent purity and are materially higher in concentrations of total nitrogen, betaine, glutamic acid and potassium. Both are lower in concentrations of sodium

than are the checks. Taking all characters into consideration, generally speaking, 52-430 X 52-307 F_1 is good in specific combining ability and 52-430 X 54-520 F_1 and 54-520 X 52-305 F_1 are poor. The poor performance of these last two F_1 hybrids as regards specific combining ability for percentage apparent purity and for concentrations of the nitrogenous characters follows very closely that of the 54-520 inbred parent.

This behavior as regards weight per root, percentage sucrose, and percentage apparent purity of F_1 hybrids for specific combining ability might have been anticipated from the investigationsof geneticists, plant breeders, chemists, and soil scientists of the beet sugar companies, State Experiment Stations, and United States Department of Agriculture. It is apparent from all of these combined researches that decided advances can be made in breeding sugar beets by taking advantage of specific combining ability. The comparisons previously discussed comparing the CMS BB_1 X A54-1, CMS BB_1 X 4W-34, and CMS BB_1 X 4W-34AR with each other and the checks indicate that improvement in both yield of roots and quality is possible by breeding for general combining ability. The comparison of the topcross hybrids CMS BB_1 X A54-1 and CMS BB_1 X 4W-34AR shows that one cycle of simple recurrent selection has resulted in an improvement in general combining ability for quality without any material decrease in yield of sugar per root. The yields in sugar per root are 0.1797 kilograms as compared with 0.1774 kilograms. The decrease noted for weight per root is not significant at the 5-percent level.

The data of most interest in group 2 pertain to general combining ability. Using CMS BB_1 as a topcross tester, inbred 34 is superior to A54-1 in general combining ability for all eight characters. However, the differences are not statistically significant at the 5-percent level for percentage sucrose, and concentrations of total nitrogen, glutamic acid, and sodium. They are statistically significant and in favor of CMS BB_1 X 34 for weight per root, purity, and potassium.

Population A58-5,which is a stock beet,is vastly superior to A54-1 in general combining ability for weight per root as determined by topcrosses with CMS BB_1. It is equally as vastly inferior in all other characteristics. Such results are not unexpected. The most interesting comparison involving CMS BB_1 X A58-5 is between the behavior of this topcross and its female parent A58-5. A nonstatistically significant reduction of 0.08 kilograms in weight per root is accompanied by very substantial increases in percentage sucrose (3.5%) and percentage apparent purity (5.9%) and material reductions in concentrations of the five other chemical characters. These results indicate that the stock beet may prove of considerable value as a source of genes conducive to high yield of roots. Therefore it may be desirable by hybridization to incorporate stock beets in populations designed to have a broad genetic base and designed for use in breeding programs endeavoring to take advantage of general and specific combining ability. However, before such a conclusion is justified much more information,and hence research,is necessary concerning the extent to which this high potential combining ability for

weight per root of the stock beet can be recombined with high sugar percentage and high percentage apparent purity.

Population A58-22 is lower than the checks in weight per root, percentage sucrose and percentage apparent purity,but its hybrid with the topcross tester CMS BB_1 as compared with the comparable hybrid involving A54-1 shows it to be equal to A54-1 in general combining ability for all characters. It has an advantage over A54-1 of being more resistant than A54-1 to the attacks of the organisms causing Cercospora leaf spot and Aphanomyces root rot.

Summary

1. The most important conclusion that can be derived from these studies is that considerable progress can be made in breeding populations of sugarbeets for commercial production that will represent decided improvement in both yield and quality.

2. This improvement will be most rapid by employing those methods of breeding designed to take advantage of specific combining ability and general combining ability.

3. Even though data presented in this study are extremely limited in scope they show that decided improvement can be made in all eight characters by utilization of specific combining ability. The same conclusions can be drawn for general combining ability but the results presented are not as striking. Hence, single crosses, double crosses, topcrosses, synthetic varieties and modifications of these populations become of considerable interest to the sugarbeet breeder.

4. The data indicate that hybrid populations are much more likely to combine many desirable characters than are nonhybrid populations of sugar beets.

5. Individual plant selection for weight per root and percentage sucrose based on phenotypic appearance and a progeny test followed by two generations of inbreeding resulted in significant increases in general combining ability for percentage sucrose, percentage apparent purity and concentration of potassium in the thin juice. This conclusion is based on comparisons with the general combining ability of the population from which the selection was made.

6. One cycle of simple recurrent selection involving population A54-1 resulted in improvement for general combining ability for all characters excepting weight per root. However, the advances for percentage sucrose, percentage apparent purity, and concentrations of potassium, taken individually, were the only ones statistically significant at the 5-percent level. The decreases in weight per root, concentrations of the three nitrogenous characters, and sodium were not statistically significant at the 5-percent level when considered individually. It would appear that one cycle of simple recurrent selection had resulted in a gradual improvement in the general combining ability of all characters, with the exception of weight per root. For this character there may have been a small loss in general combining ability.

7. The stock beet A58-5 was found to be vastly superior to the commercial variety in general combining ability for weight per root and vastly inferior for the other seven desirable characters. The data showed that some recombination of the desirable characters can be made as regards general combining ability, but further researches are necessary to determine to what extent the plant breeder can exploit this superior combining ability for weight per root of the stock beet.

Responses of Populations of Sugar Beets to Dates of Harvest As Measured by Yield and Quality 1/

In 1961 studies were conducted to determine responses of populations of sugar beets to dates of harvest as measured by yield and quality. The purposes of the study are as follows: (1) to determine what effects dates of harvest have on yield and quality characters, (2) to determine the environmental and the genetic interrelations of the characters studied at the different dates of harvest, and (3) to determine whether the responses of some populations to the different dates of harvest are such as to make it economically feasible, from the standpoint of percentage sucrose and percentage apparent purity, to start the harvest campaign from 2 to 4 weeks earlier than normally is the case.

Literature

The literature references are as follows: For methods used in making chemical determinations see Payne et al (4). For a review of the literature pertinent to quality see Carruthers et al (1) and Powers et al (6).

Materials and Design of the Experiment

The materials used in the study are as follows. There is a total of 20 populations in the experiment. One is a commercial variety, 4 are threeway hybrids each composed of 3 inbreds, and 15 are F_1 hybrids each composed of 2 inbreds. The dates of harvest are September 14, October 3, and October 16. The characters studied are weight of roots per plot, percentage sucrose, weight of sugar per plot, percentage apparent purity, and total nitrogen. Total nitrogen is expressed as milligrams per 100 milliliters of thin juice equated to a refractometer reading of 10.

The design of the experiment is a split plot with populations randomized within replications and dates of harvest randomized within blocks. Each block is composed of 3 dates of harvest and each date of harvest has 2 replications with 20 populations randomized within each replication. There are 5 such blocks. A diagram of the first block is depicted on page 180. The sources of variation and degrees of freedom are given in table 1.

1/ The writers are indebted to The Great Western Sugar Company for obtaining thin juice samples by an oxalate method standard with that company and for the percentage apparent purity determinations. These thin juice samples and the apparent purity determinations were obtained from R. R. Wood of that company.

Diagram 1. Block 1 showing the design of the experiment.

Block 1

	Border and turnway	
Replication 1	20 populations, randomized	Harvested
Replication 2	20 populations, randomized	9/14
	Border and turnway	
Replication 1	20 populations, randomized	Harvested
Replication 2	20 populations, randomized	10/16
	Border and turnway	
Replication 1	20 populations, randomized	Harvested
Replication 2	20 populations, randomized	10/3
	Border and turnway	

Table 1. Sources of variation and degrees of freedom and those used to estimate error variance. 1/, 2/

Sources of variation	Used in estimation of error	Degrees of freedom
Blocks		4
Replications		1
Populations		19
Dates of harvest		2
B X R		4
B X P	B	76
B X D	A	8
R X P	B	19
R X D		2
P X D		38
B X R X P	B	76
B X P X D	B	152
R X P X D	B	38
B X R X D		8
B X R X P X D	B	152
Error A		8
Error B		513

1/ The symbols used have the following designations: B = Blocks, R = Replications, P = Populations, and D = Dates of harvest.

2/ The writers are indebted to Dr. E. E. Remmenga for advice in designing the experiment and analyzing the data and to Dr. D. S. Robson for advice in analyzing the data.

As is indicated by the values listed in the last row of table 1, the degrees of freedom, opposite B were pooled to obtain an estimate of error variance B. In the tables that follow, error variance A is used to evaluate significance of differences between dates of harvest. Likewise, error variance B is used to evaluate the significance of differences between populations and the first order interaction populations X dates of harvest.

Results

The two main effects of interest are populations and dates of harvest and the interaction of interest is populations X dates of harvest. Degrees of freedom, estimates of variances and of error variances, and F values for populations, dates of harvest, and populations X dates of harvest are listed in table 2. It is apparent from the F values listed in table 2 that for all characters significant differences between populations exist.

Table 2. Degrees of freedom, estimates of variances and of error variances, and F values for populations, dates of harvest, and populations X dates of harvest.

Source of variation 1/	Error	Degrees of freedom	Weight per plot		Percentage sucrose		Sugar per plot		Apparent purity		Total nitrogen	
			Variance	F value	Variance	F value	Variance	F value	Variance	F value	Variance	F value
Populations	B	19 3/	22.4836	33.5877	10.4291	22.8108	0.3552	24.3288	56.1072	22.3793	2472.4167	41.8416
Dates of harvest	A	2 4/	3.2844		418.8133	16.2369	1.8506	18.8069	9.4813		562.7464	
Populations X dates of harvest	B	38 2/	0.6232		0.6468	1.4147	0.0135		3.5500	1.4160	71.1550	1.2042
Error A	A	8	8.1957		25.7939		0.0984		94.0961		6468.1976	
Error B	B	513	0.6694		0.4572		0.0146		2.5071		59.0899	

1/ The symbols used have the following designations: B = Blocks, R = Replications, P = Populations, and D = Dates of harvest.

2/ The F value at the 5% level is 1.42, and at the 1% level is 1.64.

3/ The F value at the 5% level is 1.60, and at the 1% level is 1.92.

4/ The F value at the 5% level is 4.46, and at the 1% level is 8.65.

Population averages

In table 3 are listed the averages of all 3 dates of harvest for weight per plot, percentages sucrose, sugar per plot, percentage apparent purity, and total nitrogen in the thin juice.

Table 3. Averages of all three dates of harvest for weight per plot, percentage sucrose, sugar per plot, percentage apparent purity, and total nitrogen in the thin juice, 1961.

Population	Character				
	Weight per plot	Sucrose	Sugar per plot 1/	Apparent purity	Total nitrogen
	Kg.	%	Kg.	%	Mg/100ml
52-430 X 54-565 F_1	4.802	16.3	0.74789	95.6	41.6
52-430 X 54-346 F_1	5.465	16.2	0.84686	95.7	37.4
52-305 CMS X 54-565 F_1	5.050	16.1	0.77262	94.9	45.6
52-305 CMS X (52-430 X 54-346)	5.173	15.8	0.77227	94.2	44.5
52-305 CMS X 52-430 F_1	4.560	15.8	0.67589	93.7	49.6
52-430 X 54-520 F_1	5.498	15.7	0.79892	92.9	57.6
52-430 X 52-408 F_1	7.358	15.5	1.08303	94.7	44.7
52-305 CMS X 54-346 F_1	5.052	15.6	0.74808	94.9	42.0
52-305 CMS X (52-430 X 54-520)	5.095	15.4	0.72541	92.2	65.2
52-305 CMS X 54-520 F_1	5.643	15.3	0.79552	92.1	65.6
52-305 CMS X 34 F_1	6.128	15.2	0.86642	92.9	61.3
52-430 X 52-307 F_1	7.047	15.2	1.02042	95.0	40.9
52-305 CMS X (54-458 X 34)	6.173	15.1	0.86365	92.0	60.1
52-305 CMS X (52-430 X 52-407)	5.678	14.9	0.78558	92.6	56.1
52-430 X 52-407 F_1	6.595	14.9	0.91934	93.9	49.2
54-565 X 52-407 F_1	5.625	14.8	0.77272	92.5	57.4
52-305 CMS X 54-458 F_1	5.257	14.8	0.71663	91.8	64.9
52-305 CMS X 52-407 F_1	5.542	14.7	0.74360	91.0	62.1
52-305 CMS X 52-307 F_1	5.975	14.6	0.81952	93.6	52.3
A56-3	7.843	14.0	1.02140	93.1	54.4
Average	5.778	15.3	0.82479	93.5	52.6
LSD at 5% level	0.414	0.342	0.061108	0.801	3.888

1/ The character sugar per plot was calculated by multiplying weight per plot (kg.) X percentage sucrose X percentage apparent purity.

From the averages of table 3 the following deductions can be made. A56-3, the commercial variety, produced greater weight of root per plot than any of the hybrids. The differences are significant at the 5% level. The opposite was true for percentage sucrose. That is, all of the hybrids averaged higher in percentage sucrose than did A56-3. For weight of sugar per plot the F_1 hybrid 52-430 X 52-408 averaged significantly higher than the commercial variety. This was due entirely to the higher average percentage sucrose and percentage apparent purity. Hybrid 52-430 X 52-307 yields 1.02042 kilograms of sugar per plot as compared with 1.02140 kilograms for A56-3. Hence the two populations yield approximately the same amount of sugar per plot. This is due to the fact that the hybrid is significantly higher in both percentage sucrose and percentage apparent purity but lower in weight of roots per plot and the first two characters balance the third. For percentage apparent purity and total nitrogen, A56-3 is not materially different from the averages of all the populations.

The economic significance of the above comparisons lies in the magnitude of the differences noted, resulting in possible decreases in processing costs. The F_1 hybrid 52-430 X 52-408 has a 6% increase of sugar per plot over the commercial variety. This results from increases of 1.5% in percentage sucrose and 1.6% in apparent purity. These latter increases would be expected to result in decreased costs of processing. Of course the 6 percent increase in the amount of sugar produced per plot, in itself, is of economic importance to the grower of sugarbeets.

Hence the grower and the manufacturer benefit appreciably from the increases obtained, the grower benefitting from the increased yield of sugar and the manufacturer from decreased costs of processing beets having a higher percentage apparent purity and a higher percentage sucrose.

The within populations and within dates of harvest means and the averages of all populations for each date of harvest are listed in table 4. Hence the information to be considered in this table pertains to the main effect of dates of harvest and the interaction of populations X dates of harvest.

First consider the averages for dates of harvest listed in the fourth to last row of table 4. There are increases in percentage sucrose and weight of sugar per plot from the first to last date of harvest and these differences are well established statistically. This is shown by comparing the differences for dates of harvest with the appropriate least significant differences listed in the last three rows of table 4. Also weight of roots per plot show a consistent increase from the first to the last date of harvest, but as judged from comparing the differences with the appropriate least significant difference these increases are not so well established statistically. The same is true of the decreases from the first to the last date of harvest in concentration of total nitrogen in the thin juice. Percentage apparent purity does not show any consistent differences between dates of harvest.

Table 4. The within populations and within dates of harvest means and the averages of all populations for each date of harvest for weight per plot, percentage sucrose, sugar per plot, percentage apparent purity, and total nitrogen in the thin juice.

Population	Weight			Sucrose			Sugar per plot 1/			Apparent purity			Total nitrogen		
	9/14	10/3	10/16	9/14	10/3	10/16	9/14	10/3	10/16	9/14	10/3	10/16	9/14	10/3	10/16
		Kg.			%			Kg.			%			Mg/100ml	
52-430 X 54-565 F_1	4.450	5.015	4.940	15.5	16.0	17.3	0.65940	0.76469	0.81958	95.6	95.3	95.9	40.0	44.2	40.6
52-430 X 54-346 F_1	5.500	5.535	5.360	14.6	16.3	17.7	0.76446	0.86251	0.91362	95.2	95.6	96.3	39.3	37.7	35.1
52-305 CMS X 54-565 F_1	4.705	5.140	5.305	14.6	16.2	17.4	0.64915	0.79271	0.87599	94.5	95.2	94.9	52.8	43.3	40.6
52-305 CMS X (52-430 X 54-346)	5.155	4.990	5.375	14.2	15.8	17.5	0.69102	0.74348	0.88231	94.4	94.3	93.8	48.5	42.5	42.4
52-305 CMS X 52-430 F_1	4.550	4.445	4.685	14.3	15.5	17.6	0.61226	0.64281	0.77261	94.1	93.3	93.7	50.9	50.8	47.2
52-430 X 54-520 F_1	5.560	5.650	5.285	14.2	15.8	17.0	0.73899	0.81861	0.83915	93.6	91.7	93.4	56.6	51.5	54.6
52-430 X 52-408 F_1	7.110	7.475	7.490	14.4	15.5	16.7	0.97367	1.09838	1.17703	95.1	94.8	94.1	45.8	43.5	44.9
52-305 CMS X 54-346 F_1	4.885	5.050	5.220	14.0	15.6	17.1	0.64765	0.74683	0.84977	94.7	94.8	95.2	47.9	40.7	37.5
52-305 CMS X (52-430 X 54-520)	4.895	5.095	5.295	14.1	15.4	16.7	0.63153	0.72500	0.81971	91.5	92.4	92.7	66.2	67.4	62.0
52-305 CMS X 54-520 F_1	5.560	5.745	5.625	14.1	15.2	16.6	0.72046	0.80425	0.86185	91.9	92.1	92.3	65.3	66.4	65.2
52-305 CMS X 34 F_1	6.000	6.150	6.235	13.4	15.4	16.8	0.74611	0.87796	0.97520	92.8	92.7	93.1	65.0	62.3	56.6
52-430 X 52-307 F_1	7.050	6.960	7.130	13.7	15.1	16.9	0.91466	0.99946	1.14713	94.7	95.1	95.2	42.0	40.1	40.6
52-305 CMS X (54-458 X 34)	5.590	6.330	6.600	13.8	15.0	16.6	0.71048	0.86594	1.01453	92.1	91.2	92.6	59.7	63.0	57.6
52-305 CMS X (52-430 X 52-407)	5.665	5.560	5.310	13.3	14.8	16.7	0.70070	0.75952	0.89653	93.0	92.3	92.4	58.6	57.6	52.1
52-430 X 52-407 F_1	7.140	6.495	6.150	13.3	15.0	16.5	0.89169	0.92261	0.94372	93.9	94.7	93.0	49.9	49.2	48.6
54-565 X 52-407 F_1	5.355	5.405	6.115	13.6	14.6	16.2	0.67584	0.72995	0.91237	92.8	92.5	92.1	55.8	58.1	58.4
52-305 CMS X 54-458 F_1	4.995	5.155	5.620	13.6	14.6	16.2	0.62905	0.68414	0.83669	92.6	90.9	91.9	62.8	64.9	67.0
52-305 CMS X 52-407 F_1	5.360	5.510	5.755	13.3	14.4	16.4	0.65300	0.70854	0.86926	91.6	89.3	92.1	62.1	67.2	57.0
52-305 CMS X 52-307 F_1	5.690	6.410	5.825	12.9	14.8	16.2	0.68924	0.88322	0.88609	93.9	93.1	93.9	52.9	51.4	52.6
A56-3	7.545	8.015	7.970	12.5	14.2	15.2	0.88371	1.05505	1.12543	93.7	92.7	92.9	54.6	54.8	53.8
Average	5.638	5.806	5.890	13.9	15.3	16.8	0.72915	0.82428	0.92093	93.6	93.2	93.6	53.8	53.3	50.7
LSD for populations within dates of harvest at 5% level		0.721			0.6			0.10645			1.4			6.8	
LSD for dates of harvest at 5% level		0.564			1.0			0.06180			1.9			15.8	
LSD for interactions at 5% level		1.019			0.8			0.15055			2.0			9.6	

1/ The character sugar per plot was calculated by multiplying percentage sucrose X percentage purity X weight per plot (kg.).

It is apparent from the above comparisons that the greatest gain in delaying harvest comes from an increase in percentage sucrose. In going from the September 14 to the October 3 date of harvest there is an increase of 1.4 percent sucrose and going from the October 3 date of harvest to October 16 there is an additional increase of 1.5 percent. This makes a total increase of 2.9 percent sucrose in going from the September 14 date of harvest to the October 16 date of harvest.

Considerable importance lies in the possibility of interactions and they will be considered next. The F values listed in table 2 show that the only interactions statistically significant at the 5% level are for percentage sucrose and percentage apparent purity. The only other character for which the odds are in favor of the interactions, but not statistically significant at the 5% level, is concentration of total nitrogen in the thin juice.

The most probable interactions for percentage sucrose involve 52-430 X 54-565 F_1 compared with other populations. For example, the comparisons involving this F_1 hybrid and A56-3 (the commercial variety) are (15.5 - 17.3) - (12.5 - 15.2) for the dates September 14 and October 16. Completing the calculations gives a value of 0.9 which compares favorably with an LSD of 0.8. Further research is necessary to firmly establish the reality of such an interaction. If such an interaction is confirmed, it is of considerable importance to the industry, because it indicates that some populations have comparatively higher percentages of sucrose at the earlier dates of harvest. Also it is desirable to conduct research designed to determine to what extent such a character can be enhanced.

One interaction for percentage apparent purity that may have real significance is that involving 52-430 X 54-346 F_1 and 52-430 X 52-408 F_1. The comparison involving dates September 14 and October 16 is (95.2 - 96.3) - (95.1 - 94.1). Completing the calculations produces a value of -2.1. Since this is a selected comparison the interaction is not well established statistically. However, if confirmed by further research, this finding is of considerable economic importance to the industry. Those growers and manufacturers desiring to conduct early harvests would like to grow those populations which tend to reach maximum percentage purity at the earlier dates of harvest. It should be noted that the difference between the two populations compared lies in the percentages apparent purity for the October 16 date of harvest. If F_1 hybrids such as 52-430 X 54-346 can be bred that reach a maximum of 96.3 percent apparent purity at the first date of harvest and if they possess satisfactory yield, such hybrids would be of considerable value to the beet sugar industry. Since the average percentages of apparent purity for all the populations do not differ for September 14 and October 16, the production of hybrids having maximum percentage apparent purity at the earlier dates of harvest appears very feasible.

Association of characters

The association of characters due to environmental differences and to genetic differences is shown in tables 3 and 4.

Primarily environmental differences

The environmental differences for dates of harvest are shown by the averages listed opposite the row heading "average" in table 4. A very minor amount of genetic variability is confounded with the environmental differences. It has been shown that the only significant differences at the 5-percent level between dates of harvest are for the characters percentage sucrose and sugar per plot. However, there is a consistent increase in weight per plot and a consistent decrease in concentration of total nitrogen in the thin juice in going from the first date of harvest to the last date of harvest. The increase in percentage sucrose in going from the first to the last date of harvest has considerable economic importance. The average percentage sucrose for the September 14 date of harvest is 13.9 and for the October 16 date of harvest is 16.8, representing an increase of 2.9 percent in sucrose.

This environmental increase of 2.9 percent sucrose is independent of apparent purity as the percentages apparent purity are identical for the first and last dates of harvest and the second date of harvest is not materially different from them. It is doubtful whether the positive association between percentage sucrose and weight of root is real as the differences between dates of harvest for weight of roots per plot are small and the odds against their being chance deviations from a common value are also small. The same is true for the association between percentage sucrose and concentration of total nitrogen in the thin juice. The difference of 3.1 mg per 100 ml of thin juice equated to a refractometer reading of 10 between the first and last dates of harvest is not sufficient to indicate that a significant association between an increase in percentage sucrose is materially associated with a decrease in total nitrogen. This is confirmed by the fact that some populations such as 52-305 CMS X 54-458 F_1 show an opposite relation. In this comparison involving the first and last dates of harvest there is an increase of 3.1 percent in sucrose and an increase of 4.2 mg of total nitrogen in the thin juice. However, none of these comparisons for total nitrogen are significant at the 5% level. From these considerations it is apparent that the decided increase in percentage sucrose is not dependent upon a material decrease in the concentration of total nitrogen in the thin juice.

The increase in sugar per plot in going from the first to the last date of harvest is primarily due to the increase in percentage sucrose. Hence, as can be seen from the values listed opposite the row heading "Average" of table 4, there is close association between sugar per plot and percentage sucrose. Both increase from the first to the last date of harvest.

Primarily genetic differences

The genetic differences for populations are given by the means listed in table 3. A minor amount of environmental variability is confounded with the genetic variability as represented by differences between means of populations.

The average genetic association of the characters is shown by the correlation coefficients listed in table 5.

Table 5. Correlation coefficients calculated from the population means listed in table 3.

Characters correlated	Correlation coefficient r 1/	$r^2(100)$
		%
Weight of roots per plot X percentage sucrose	-0.58	34
Weight of roots per plot X weight of sugar per plot	0.95	90
Weight of roots per plot X percentage apparent purity	-0.00	0
Weight of roots per plot X concentration of total nitrogen	-0.03	1
Percentage sucrose X weight of sugar per plot	-0.29	8
Percentage sucrose X percentage apparent purity	0.63	40
Percentage sucrose X concentration of total nitrogen	-0.54	29
Weight of sugar per plot X percentage apparent purity	0.27	7
Weight of sugar per plot X concentration of total nitrogen	-0.28	8
Percentage apparent purity X concentration of total nitrogen	-0.95	90

1/ The value of r approximates 0.088 at the 5% level and 0.115 at the 1% level.

Weight of roots per plot is negatively associated with percentage sucrose, 34 percent of the variability of one being accounted for by that of the other. The regression of weight of root per plot and weight of sugar per plot accounts for 90 percent of the variability of these two characters. For all practical purposes, weight of root per plot and percentage apparent purity and weight of root per plot and concentration of total nitrogen in the thin juice are independent.

Percentage sucrose is negatively associated with weight of sugar per plot and concentration of total nitrogen in the thin juice and is positively associated with percentage apparent purity. Forty percent of the variability of percentage sucrose and percentage apparent purity is accounted for by regression. If percentage apparent purity were independent of weight of roots per plot, one would expect percentage sucrose and weight of sugar per plot to be positively associated. This must be so, as weight of sugar per plot is calculated by multiplying weight of roots per plot, percentage sucrose, and percentage apparent purity. Only 29 percent of the variability of percentage sucrose and the variability of concentration of total nitrogen is accounted for by regression. The percentages of the variability of percentage sucrose and the other characters accounted for by regression leave considerable of the genetic variability independent and hence allow considerable leeway for recombination of characters. This is true even though percentage sucrose shows some degree of association with all the other characters.

Also weight of sugar per plot is associated with all of the other characters, being positively associated with weight of roots per plot and percentage apparent purity and negatively associated with percentage sucrose and concentration of total nitrogen. Calculated weight of sugar per plot is a dependent character and all of its variability must be accounted for by weight of root per plot, percentage sucrose, and percentage apparent purity.

Percentage apparent purity is independent of weight of root per plot but is associated positively with percentage sucrose and weight of sugar per plot. It is highly negatively associated with concentration of total nitrogen in the thin juice, 90% of the variability of one being accounted for by that of the other.

Recombination of characters

It is of interest for both theoretical and practical reasons to determine to what extent the characters under study are recombined in

the populations studied. This is true because such a study should furnish some evidence as to further progress that can be made toward combining these characters in favorable combinations.

The population having the lowest weight of roots per plot, 4.560 kilograms, has 15.8 percent sucrose, whereas the population having the highest weight of roots per plot has 14.0 percent sucrose, a difference of 1.8 percent. However, the population having the next highest weight of roots per plot, 7.358 kilograms, has 15.5 percent sucrose, a decrease of only 0.3 percent. Hence in going from the lowest weight to the highest there is an increase in weight per plot of 72 percent accompanied by a decrease of 1.8 percent in sucrose, whereas in going from the lowest weight per root to the second highest there is an increase in weight per plot of 61 percent accompanied by a decrease of only 0.3 percent. This difference is not quite significant at the 5% level. There seems no good reason for believing the maximum has been reached in combining weight of roots per plot and percentage sucrose.

It will be remembered that weight of roots per plot and percentage apparent purity are independent. The population having the lowest weight per plot, 4.560 kilograms, had a purity of 93.7 percent, whereas the population having the highest weight per plot had a purity of 93.1 percent. The difference of 0.6 percent is not statistically significant at the 5% level. The population having the next highest weight of roots per plot had a purity of 94.7 which is materially higher than the purity of the plot having the lowest weight of roots per plot. There seems to be no reason why the higher weights of roots per plot cannot be recombined with the higher percentages of purity by appropriate breeding procedures.

Also, weight of roots per plot and concentration of total nitrogen in the thin juice are genetically independent (see correlation coefficient of table 5). From the data in table 3 it can be seen that the population having the lowest weight per plot has 49.6 milligrams of total nitrogen per 100 milliliters of thin juice, whereas the comparable figure for the population having the highest weight per plot is 54.4 milligrams, and the population having the second highest weight per plot had a concentration of 44.7 milligrams. All three of the means are significantly different at the 5% level. From this study of the genetic associations there seem to be good reasons for assuming that the lower concentrations of total nitrogen in the thin juice can be recombined with higher weights of roots per plot. Since the differences noted are to a great extent genetic it should be possible to accomplish this desired recombination by breeding procedures.

Combining ability

Oldemeyer (3) used a commercial sugar beet variety and the German red beet as topcross testers to determine the general combining ability of inbred lines of sugar beets and concluded that the German red beet was satisfactory for determining the general combining ability for yield and percentage sucrose. Peterson and Dickenson (5) using the German red-marker beet to test for general combining ability found that the single crosses showing the greatest production of sugar per acre were those whose parents were high in general combining ability when tested by crossing with the red-marker beet and at the same time showed heterosis for percent sucrose.

Oldemeyer and Rush (2) made a very interesting study using male-sterile testers. Seventeen self-fertile inbred lines and one open pollinated variety of sugar beets were crossed to five cytoplasmic male tester lines. The hybrids were grown in a field test including the parents. The results showed that there were differences among the inbred lines for general combining ability and that specific combining ability is important particularly in regard to yield. Heterosis and phenotypic dominance were found for both yield and sucrose. Parental performance showed little association with combining ability, indicating the necessity of making test crosses in evaluating inbreds. The variance attributable to the males and females was considered an index of that part of the over-all variation among the test crosses due to the general combining ability of the parents. The interaction male X female variance was considered an index of that part of the over-all variation due to specific combining ability. To study the effect of specific combining ability, the means of the individual crosses were adjusted by adding to or subtracting from them the deviations of the means of all respective crosses of each parent from the test averages.

Of the 513 degrees of freedom listed in table 2, 299 are available for studying combining ability. In these studies there were two female parents designated as inbreds 52-430 and 52-305 CMS. The male parents were five different inbreds hybridized with each of these female parents. The pertinent degrees of freedom, mean squares and F values for weight per plot are listed in table 6.

Table 6. Degrees of freedom, mean squares and F values for F_1 hybrids of 52-430 and 52-305 CMS having 5 male parents in common, weight per plot.

Source of variation	Degrees of freedom	Mean square	F value		
			Obtained	0.05 level	0.01 level
Female parents	1	13.803075	19.20	3.89	6.76
Male parents	4	23.980612	33.36	2.41	3.41
Blocks	4	1.405488			
Replications	1	0.027075			
Dates of harvest	2	0.652058			
F X M	4	5.967429	8.30	2.41	3.41
Error variance	234	0.718927			

A study of table 6 reveals that for weight per plot the female parents differ, male parents differ, and the interaction of females X males is statistically significant. That is, the parents show specific combining ability. For weight of root, dates of harvest did not differ materially either from a biological or a statistical standpoint.

The detailed data pertaining to general and specific combining ability are listed in table 7. Inbreds 52-307 and 52-407 have higher combining ability with 52-430 than with 52-305 CMS for weight per root. Such is not the case for 54-565 and 54-520. The combining ability of these two inbreds with the female parents is not materially different. In general for weight per root the female parent 52-430 has the higher combining ability. As might be expected due to the high degree of association between weight per plot and weight of sugar per plot, these two characters follow very similar behavior patterns as regards combining ability. Both exhibit specific combining ability.

Table 7. Means of three dates of harvest for F_1 hybrids of 52-430 and 52-305 CMS having the male parent in common, 1961.

Character and female parent	Male parent					Average	LSD at 5% level
	54-565	54-346	54-520	52-307	52-407		
Weight							0.414
52-430	4.802	5.465	5.498	7.047	6.595	5.881	
52-305 CMS 1/	5.050	5.052	5.643	5.975	5.542	5.452	
Sucrose							0.342
52-430	16.3	16.2	15.7	15.2	14.9	15.7	
52-305 CMS 1/	16.1	15.6	15.3	14.6	14.7	15.3	
Sugar per plot							0.061108
52-430	0.74789	0.84686	0.79892	1.02042	0.91934	0.8667	
52-305 CMS 1/	0.77262	0.74808	0.79552	0.81952	0.74360	0.7759	
Apparent purity							0.801
52-430	95.6	95.7	92.9	95.0	93.9	94.6	
52-305 CMS 1/	94.9	94.9	92.1	93.6	91.0	93.3	
Total nitrogen							3.888
52-430	41.6	37.4	57.6	40.9	49.2	45.3	
52-305 CMS 1/	45.6	42.0	65.6	52.3	62.1	53.5	

1/ This is the B_4 generation obtained by backcrossing cytoplasmic male sterile plants to inbred 52-305.

Percentage apparent purity shows the same tendency. The interaction [(52-430 X 54-565) - (52-305 CMS X 54-565)] - [(52-430 X 52-407) - (52-305 CMS X 52-407)] gives a value of -2.2 percent. This is of sufficient magnitude to be of biological importance if substantiated by further research. It should be noted that even though an interaction is indicated, in both cases the hybrid with 52-430 has the higher percentages apparent purities.

The combining ability behavior patterns for percentage sucrose and concentrations of total nitrogen in the thin juice are somewhat different. That is, these characters exhibit only general combining ability. Inbred 52-430 has more favorable general combining ability for percentage sucrose and for concentration of total nitrogen in the thin juice.

When interpreting the above data it must be kept in mind that the number of inbred lines used in the study is small and hence the number of genotypic combinations represented by the F_1 hybrids is small also. Hence, their value for drawing general conclusions is correspondingly limited.

Conclusions

One of the main purposes of the study was to determine whether the responses of some populations to the different dates of harvest are such as to make it economically feasible, from the standpoint of percentage sucrose and percentage apparent purity, to start the harvest campaign from 2 to 4 weeks earlier than normally is the case. From the data in table 4 it can be seen that the F_1 hybrid 52-430 X 54-565 has 0.3 percent higher sucrose and 2.7 percent higher apparent purity than the commercial variety (A56-3) harvested approximately one month later (September 14 as compared with October 16). Further total nitrogen is 13.8 mg/100ml lower in this F_1 hybrid harvested on September 14 than it is in the commercial variety harvested on October 16.

Further, at the month earlier date of harvest the reduction in weight of roots per plot is only 4.3 percent for an average of all populations. There is no change in percentage apparent purity nor concentration of total nitrogen in the thin juice. However, percentage sucrose is 2.9 percent higher when the populations are harvested a month later.

It can be concluded that from the standpoint of percentage sucrose F_1 hybrids can be bred that harvested one month earlier than the commercial variety are its equal. Such hybrids in this study had significantly higher percentage apparent purity and a significantly lower concentration of total nitrogen in the thin juice than the commercial variety.

Even though no such F_1 hybrid was included in these studies, the data indicate that hybrids having higher percentage sucrose and higher percentage apparent purity at the earlier dates of harvest and lower concentrations of total nitrogen in the thin juice need not have lower weights per root than the commercial variety. That is, these four desirable characters can be recombined into one population, hybrid or otherwise. However, the data indicate it will be difficult, if at all possible, to obtain populations that reach the maximum percentage sucrose at the earlier dates of harvest.

It can be concluded from these studies that populations can be bred which will produce satisfactory yields of roots, percentage sucrose and percentage apparent purity, as compared with presently grown commercial varieties, when harvested one month earlier. Hence it appears highly probable that populations can be bred which will make it economically feasible to start the harvest campaign from 2 to 4 weeks earlier than is the case at the present time.

Summary

1. As might be expected, for all characters significant differences exist between populations harvested on each of the dates September 14, October 3, and October 16.

2. Percentage sucrose and weight of sugar per plot increased in going from the first to the last date of harvest and the differences noted are highly statistically significant. This was also true for weight per plot, but the differences noted, taken individually, were not significant at the 5% level. The increase of the last date of harvest over the first date of harvest for weight per plot was only 4.3 percent. The same is true of the decreases from the first to last date of harvest in concentration of total nitrogen in the thin juice. Percentage apparent purity does not show any significant or consistent changes with dates of harvest.

3. For percentage sucrose the interaction involving populations and dates of harvest is significant at the 5% level. Further research is desirable to firmly establish the reality of such an interaction. If such an interaction is confirmed, it is of considerable importance to the beet sugar industry because it indicates that some populations have comparatively higher percentages of sucrose, comparing dates within a population, than others at the earlier dates of harvest.

4. With the possible exception of the high negative association found between percentage apparent purity and concentration of total nitrogen in the thin juice, none of the associations was sufficiently great so as to preclude recombination of characters by the plant breeder.

5. Differences in both general and specific combining ability were found for weight per plot and weight of sugar per plot. Only general combining ability favorable to production of beet sugar was found for percentage sucrose, percentage apparent purity, and concentration of total nitrogen in the thin juice. However, as estimated, if an inbred has good general combining ability it must also have good specific combining ability in hybrids with some inbreds. When interpreting the data, it must be kept in mind that the number of F_1 hybrids included in these studies is very small.

6. It seems highly probable that populations (hybrids or others) can be bred which will make it economically feasible to start the harvest campaign from 2 to 4 weeks earlier than is the case at the present time.

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The Use of Tetrazolium Salts in Determining the Viability of Sugarbeet Pollen

The increased use of stored pollen and cytoplasmic male sterility in sugarbeet breeding necessitates determining the viability of pollen at the time of its use or at the time of anther dehiscence. The usual pollen-staining techniques in sugarbeets, such as aceto-carmine or iodine, are not vital stains and hence do not differentiate between viable pollen and pollen which has lost its viability. Hence, a stain specific for living mature pollen would be a useful tool to persons working with stored pollen or pollen treated in any possibly lethal manner. Such a stain would also be of value in the classification of individuals with different degrees of male sterility.

The tetrazolium salts which are reduced to insoluble colored products (monoformazans or diformazans) by action of dehydrogenase enzymes linked to respiratory processes seem to offer possibilities for this purpose. The development of 2,3,5-triphenyl tetrazolium chloride (TTC) and some of its applications to biology has been reviewed in detail by Smith (8)[1]. This chemical was first prepared by von Pechmann and Runge in 1894 and found by Kuhn and Jerchel in 1941 to cause a red coloration in cells of yeasts, bacteria, and water cress. Lakon (2, 3) in 1942 found it possible to determine germination percentage of cereal grains and corn by treating exposed embryos with TTC. He found that the percentage of those embryos stained red was not different from the percentage which germinated in a standard germination test. However, MacLeod (4) found that under a narrow range of conditions of grain moisture and temperature TTC results grossly overestimated germination. This was due to the fact that seed germination was more sensitive to heat damage than was enzymatic activity. This salt has been used in various tests in many types of tissues. According to Porter, Durrell, and Romm (7), the salt is an oxidation-reduction indicator, and the development of the nondiffusible red color in a specific tissue is in general an indication of the presence of active respiratory processes.

Vieitez (9) in 1952 reported that a two percent TTC solution at 50° C. provided a quick and reliable index of pollen viability in maize. However, Oberle and Watson (5) in 1953 reported that TTC stained to varying degrees certain fruit pollen known to be nonviable and concluded that the chemical was of no value as an indicator of pollen germinability for peaches, pears, apples, and grapes.

Other tetrazolium salts and derivatives have been formulated. Some of these have been found to be of value in the localization and quantitative

1/ Numbers in parentheses refer to literature cited.

measure of certain reducing enzymes. Pearse (6) found 2-(p-iodophenyl)-3-(p-nitrophenyl)-5-phenyl tetrazolium chloride to be rapidly reduced to a red monoformazan under aerobic conditions. He further found 3-(4,5-dimethylthiazolyl-2)-2,5-diphenyl tetrazolium bromide to be rapidly reduced to a blue or purple diformazan.

This study was conducted to determine whether certain of these newer tetrazolium salts are of value in determining the viability of sugarbeet pollen.

Materials and Methods

A series of eight tetrazolium salts were tested for their vital staining capacity of beet pollen. The eight salts were as follows:

1. 2,3,5-triphenyl tetrazolium chloride
2. tetrazolium blue
3. tetrazolium violet
4. tetrazolium red
5. nitro-blue tetrazolium
6. neotetrazolium chloride
7. 3-(p-iodophenyl)-2-(p-nitrophenyl)-5-phenyl tetrazolium chloride
8. 3-(4,5-dimethylthiazolyl-2)-2,5-diphenyl tetrazolium bromide

The salts were dissolved in distilled water in varying concentrations. Salts 1 and 4 were readily soluble in cold water, 7 and 8 were soluble upon heating nearly to the boiling point, and 2, 3, 5, and 6 were soluble upon being brought to the boiling point.

The salts were tested at the following four concentrations and three temperatures: 0.2, 0.5, 1.0, and 2.0 percent each at 20°, 35°, and 50° centigrade. Examination of the pollen was made at intervals of 3, 5, 10, 15, 20, 30, and 40 minutes. Preliminary tests were made on pollen from the stock beet Ovana, as pollen was most abundant on this population at the time of the study. After determining those salts which exhibited vital staining ability they were then tested to determine the most effective concentration and temperature. The following populations were used in these tests.

1. 52-430 (inbred)
2. 52-307 (inbred)
3. 52-305CMS (cytoplasmic male sterile inbred)
4. Ovana (stock beet)
5. (52-305CMS X Ovana)

Population 5 was segregating for male-sterile, semisterile, and fertile types. The semisterile individuals were those with yellow shrunken anthers.

The study was conducted during the winter of 1961-62 using plants grown in the greenhouse. All pollen from the fertile plants was collected about 9:00 in the morning from anthers which had dehisced that morning. Anthers from newly opened flowers were used from the sterile and semi-sterile individuals. Four sources of nonviable pollen were also tested at the most effective concentrations and temperatures of those salts which had vital staining ability. One of these sources of nonviable pollen had been collected and stored frozen without humidity control for about two and a half years. This pollen had been previously determined to be ineffective in fertilization of cytoplasmic male-sterile plants. The other sources of nonviable pollen were fresh pollen which had been killed in 70 percent ethanol, fresh pollen which had been heat killed in an electric oven held at 80° C. for 15 minutes, and fresh pollen heat killed by holding it at 110° C. for 15 minutes.

The germinability of all pollen sources was tested using an agar/sucrose culture medium as outlined by Artschwager and Starrett (1). This medium was 1.5 percent agar and 40 percent sucrose. The incubation period was seven hours at 32° C.

It was found most convenient to drop the tetrazolium solution on the pollen grains on a glass microscope slide, mix slightly, and then cover this suspension with a glass cover slip. The slides were then set aside in daylight until examined.

Results and Discussion

Of the eight salts tested, only four exhibited a vital staining capacity on fresh pollen. These were salts 1, 4, 7, and 8. Salts 1 and 4 reacted very similarly, while 7 and 8 were also similar in reaction except for color. The deepest staining and most rapid reaction with salts 1 and 4 took place in 2.0-percent solution at 20° C. Most morphologically mature pollen were stained pink to deep red after 25 minutes. Only very slight staining took place in the 0.2-percent solutions of salts 1 and 4. Salts 7 and 8 were most effective in a 0.5-percent solution at 35° C. After five minutes most morphologically mature pollen were stained pink to red by salt 7 and purple to deep purple by salt 8. These reactions were nearly as rapid in a 0.2-percent solution. With these salts a 2.0-percent solution resulted in no staining reaction. In general, the staining was more rapid for all salts as the temperature increased except for the 2.0 percent concentration where the threshold of activity was evidently exceeded. This high concentration coupled with high temperatures, 50° C., resulted in no staining by any of the salts. The reaction of salts 1 and 4 at all concentrations and temperatures was rather slow and not completely positive, as it was sometimes difficult to distinguish between the light pink pollen and the nonstained pollen. The reaction of salts 7 and 8 was more rapid and much more positive. This was particularly true of salt 8.

Rupture of morphologically mature pollen grains was noted in solutions of salts 1, 4, and 8. The rapidity of the rupture increased with the concentration and the temperature. Rupture could be due to the low osmotic concentration of the solution and not to a direct result of the salt. In salt 8, at all concentrations, the staining reaction was complete before any cell rupture was noted. This was not the case in salts 1 and 4 where rupture often occurred in cells which were unstained or only slightly stained. Cell rupture was not noted in salt 7; however, there were minute insoluble particles in the solution which somewhat interfered with the observations. Even though salt 7 was much more positive in its reaction than salts 1 and 4, it was not as positive as the reaction of salt 8.

The reaction of each salt was the same in all pollen fertile populations tested. Among the semisterile individuals, one had about nine percent morphologically mature pollen. This mature portion stained in the same manner as that of pollen from the pollen-fertile plants. The nonmature portion did not stain. All pollen from the cytoplasmic male-sterile plants and from all but one of the semisterile plants was abortive in appearance and was not stained by any of the solutions. It will be noted in table 1 that the nonstaining portion of the fresh pollen from fertile plants ranged from 16.8 to 38.9 percent. This nonstaining group consisted of from one to three percent morphologically mature pollen while the remainder appeared to have aborted at an early stage of development.

These same pollen sources were tested for germinability on an agar/sucrose medium. After seven hours of incubation the pollen tubes of the germinated pollen grains were up to 200 microns in length. The percentage of germination varied somewhat between populations, with Ovana pollen having the greatest germinability. However, even in Ovana this germination was only 13.9 percent. This might be expected, since in reviewing this subject Artschwager and Starrett (1) state that N. Favorsky in 1928 had obtained poor germination of sugarbeet pollen (not more than 30 percent). This is attributed partly to pollen degeneration in the later stages of its development resulting in nonviable but morphologically mature pollen. In their own studies, Artschwager and Starrett (1) reported pollen to germinate easily and abundantly; however, they did not report actual percentages. It would appear from work summarized by Artschwager and Starrett (1), and from this study, that there are additional unexplained factors affecting the germinability of sugarbeet pollen on the artificial medium used. Optimum conditions for germination have not been accurately determined. Hence, the percentage germination of pollen on the culture medium is not likely to be a good direct measure of pollen viability.

The four sources of pollen known to be nonviable were tested in salts 1, 4, 7, and 8 at those concentrations and temperatures which exhibited the most favorable reaction with fresh pollen. Salts 1 and 4 each caused a light-pink color in the two and one-half year old pollen, particularly in those pollen grains near the periphery of the cover slip, while salt 7 stained red about one percent of the pollen which had been

heat killed at 80° C. for 15 minutes. Salt 8 resulted in no staining of any of these nonviable pollen sources. No pollen germination occurred in any of these sources when incubated on agar/sucrose medium.

Since salt 8 was the only solution which resulted in no staining of the pollen known to be nonviable, it was tested further on pollen which had been exposed at room temperature for three and eight hours.

According to Artschwager and Starrett (1) the viability of pollen under Colorado field conditions does not extend beyond a day. They further report that it often loses its viability in less than three hours when stored in a shallow glass dish in daylight at room temperature.

The results for such treatments compared with fresh pollen are summarized in table 1 for salt 8.

Table 1. Pollen germination and development of purple color in a 0.5 percent solution of 3-(4,5-dimethylthiazolyl-2)-2,5-diphenyl tetrazolium bromide.

Population and treatment 1/	Percent germination	Percent purple color
52-307		
fresh pollen	9.1	64.3
exposed 3 hours	0.0	0.0
exposed 8 hours	0.0	0.0
52-430		
fresh pollen	12.3	61.1
exposed 3 hours	0.1	6.8
exposed 8 hours	0.0	0.0
Ovana		
fresh pollen	13.9	83.2
exposed 3 hours	0.2	7.5
exposed 8 hours	0.0	0.0
frozen 96 hours	0.0	20.6

1/ Fresh pollen was stained or incubated immediately after collection. Exposed pollen was stored in the collection dish in daylight at room temperature for the specified period.
Frozen pollen was stored in a tightly corked container at -30° C. for 96 hours without humidity control.

Exposure of pollen in daylight at room temperature apparently reduced its viability drastically. This is reflected in both germination and staining percentages. The pollen from all sources neither germinated nor stained after the eight-hour exposure. There would appear to be a relationship between the percentage germinated pollen and stained pollen.

Included in this table is a treatment in which the Ovana pollen was frozen at -30° C. for 96 hours. After this treatment the pollen failed to germinate on agar/sucrose medium; however, 20.6 percent of the pollen was stained purple to deep purple by salt 8. It is doubtful that the pollen treated in this manner was completely nonviable, since sugarbeet pollen has remained viable for at least four months when stored at low temperatures[2]. Vieitez (9) reported that maize pollen was not stained by TTC after it had been cooled to 0° C., and he referred to this as an "enzyme inhibitor treatment". It is apparent, however, from pollen storage studies that this would not be a permanent enzyme inhibitor treatment in sugarbeets.

Salts 1 and 4 were found to have no staining ability when the suspension of pollen in the solution was not covered by a cover slip. Salts 7 and 8, however, exhibited the same staining ability whether covered or uncovered.

When the slides were prepared and immediately placed in darkness no staining reaction was noted in salts 1 and 4. Salts 7 and 8 stained equally well in either light or darkness.

After two days, solutions of salts 1 and 4 had lost most of their staining capacity. This cannot be explained by a difference in pollen but could possibly have resulted from a pH change of the solution. This possibility was not investigated. Salts 7 and 8 maintained their staining ability even after being in solution for 28 days. A slightly black precipitate appeared in salt 8 but did not alter its effect.

When a drop of the solution of salt 8 was placed on the germinated pollen the percentage stained was only slightly less than that recorded in table 1 for fresh pollen. Hence, there were many stained but ungerminated pollen grains. Among the germinated pollen grains the cytoplasm of both the pollen cell and tube was stained. Rarely were there individual pollen grains which had germinated but did not stain.

In considering all salts under the conditions tested, salt 8 was the only one which did not result in some degree of staining of pollen known to be nonviable. In addition, this salt was the most rapid and positive in

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2/ Unpublished data of LeRoy Powers and J. W. Dudley in Sugar Beet Research, 1958 Report, CR 4-59, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture.

its reaction. Its most rapid reaction resulted when used in a 0.5-percent solution at 35° C. However, since the reaction is quite rapid, leading to considerable cell rupture after 15 minutes, it is much more convenient to use a 0.5-percent solution at about 20° C. which leads to a reaction equally as effective but slightly less rapid. This allows greater latitude in the period of examination. Examinations are made most easily after five to twenty minutes. After 30 minutes at 20° C. there is considerable cell rupture and draining of the cytoplasm, leaving empty cell walls which are somewhat difficult to discern from nonstained pollen cells.

This study indicates that 3-(4,5-dimethylthiazolyl-2)-2,5-diphenyl tetrazolium bromide has utility as an indicator of pollen viability in sugarbeets. It did not stain pollen which was known to be nonviable. The percentage of pollen stained was much greater than the percentage which actually germinated. However, there is reason to believe that all viable pollen was not germinated on the artificial media used in this study. Optimum conditions for germination of sugarbeet pollen have not been accurately determined. There remains the possibility that a narrow range of conditions may exist in which pollen germinability is inhibited but enzymatic activity continues. If this were true it could lead to an erroneous conclusion using salt 8 as an indicator. Under the limited set of conditions in this study this possibility was not detected.

These salts tested were from a single cource (Nutritional Biochemicals, Cleveland). However, it is assumed that the salts from all sources should be sufficiently uniform to give similar reactions.

Summary

Studies were conducted endeavoring to find a tetrazolium salt which would rapidly and accurately determine the viability of mature sugarbeet pollen.

Eight tetrazolium salts were tested for their staining capacity at concentrations of 0.2, 0.5, 1.0, and 2.0 percent and at temperatures of 20°, 35°, and 50° C. Positive results were obtained with four of the salts. Of these four the most positive and effective was 3-(4,5-dimethylthiazolyl-2)-2,5-diphenyl tetrazolium bromide in a concentration of 0.5 percent at 20° C.

The percentage of pollen grains stained by this compound was related to the percentage germinated on artificial medium but was in all cases greater. It is believed, however, that all viable pollen was not germinated on the artificial medium.

The mature pollen grains assumed to be viable were stained an easily distinguishable purple to deep purple color. Nonviable mature pollen was not stained nor was abortive pollen from cytoplasmic male-sterile plants.

The results obtained indicate that a 0.5-percent solution of 3-(4,5-dimethylthiazolyl-2)-2,5-diphenyl tetrazolium bromide at 20° C. provides a specific and rapid means of determining the viability of mature sugarbeet pollen.

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Polycross Progeny Test in a Broad-Base Monogerm Population

This is a report on a polycross progeny test involving a genetically broad-base monogerm population and is the second portion of a three-stage study to obtain fundamental information on methods of breeding sugarbeets. The overall experiment is designed as a breeding methods and population genetics study in a broad-base monogerm population for the purpose of measuring the genetic shift resulting from selection and other methods of breeding. The first portion of the study was discussed in the Report of 1960 and was entitled "Selection and Population Genetics Study in a Broad-base Monogerm Population".1/

Materials and Methods

The experimental material was grown in 1961. The characters under study were weight per root and percentage sucrose. The design of the experiment was a randomized complete block within groups with ten replications. Of the 47 genetically superior roots selected to go into the 1960 polycross plot, sufficient seed was harvested from 33 to permit their being included in the 1961 polycross progeny test. The 33 progeny lines were randomly divided into three groups of eleven progeny lines each. There were five entries common to all groups. These were (1) SLC 15 BB_1, the original broad-base population segregating for the monogerm character, (2) two entries of SLC 15 BB_2, the second open-pollinated generation rogued to monogerm, (3) inbred 34, and (4) the F_1 hybrid 52-430 X 52-407. Entries were randomized within groups and groups were randomized within replications. Plots consisted of single 20-foot rows with 44-inch spacings between rows. Within-row spacings were ten inches. Ten competitive roots were harvested from each plot, resulting in a population size of 100 for each of the progeny lines and 300 for the five common entries. The roots were individually analyzed.

The inbred and F_1 hybrid were included in the experiment to obtain a measure of the environmental variability and to provide a means of testing the reliability of methods. The duplicate entry of SLC 15 BB_2 provides a comparative measure of the true environmental variance.

1/ Sugar Beet Research, 1960 Report, CR 4-61, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture.

Experimental Results and Discussion

Characters of interest will be discussed separately, then jointly.

Percentage Sucrose

In evaluating the progeny performance, calculation of the probabilities and odds that the 33 progeny lines were superior to the material from which they were selected (SLC 15 BB_2) revealed that 17 of the 33 lines had odds of greater than 99:1 of being superior for percentage sucrose. Twenty-four of the 33 had odds of greater than 19:1 of being superior. These probabilities and odds for all progeny lines are shown in table 1. They were calculated within groups based on the mean of SLC 15 BB_2 in each particular group, even though an analysis of variance of the 5 entries common to all groups showed that there were significant differences between populations but not between groups. The within-group means were based on 200 observations and hence are quite reliable.

Table 1 Means, distribution of recurrent selections, and probability and odds that progeny lines are better than the parent material from which they were selected; percentage sucrose.

Progeny line or population	Mean	Probability	Odds	Number of recurrent selections 1/
	%			
Group I				
Sel. 3-6	15.3	0.9798	49:1	
Sel. 3-15	14.8			
Sel. 5-8	15.4	0.9896	95:1	
Sel. 5-16	14.9			
Sel. 6-4	15.4	0.9974	384:1	
Sel. 6-16	14.5			
Sel. 6-17	15.9	0.9999	1000000:1	
Sel. 7-11	15.3	0.9778	44:1	2
Sel. 7-17	15.3	0.9693	32:1	
Sel. 7-18	15.9	0.9999	1000000:1	
Sel. 8-3	15.1	0.7794	4:1	5
Group II				
Sel. 8-8	16.2	0.9999	1000000:1	
Sel. 8-19	15.1	0.8810	7:1	
Sel. 9-11	16.1	0.9999	1000000:1	9
Sel. 9-19	15.2	0.9370	15:1	
Sel. 11-5	15.8	0.9999	1000000:1	
Sel. 13-19	15.6	0.9997	3332:1	9
Sel. 14-1	15.8	0.9999	100000:1	7
Sel. 14-12	15.9	0.9999	1000000:1	8
Sel. 21-7	15.3	0.9857	69:1	
Sel. 22-9	15.9	0.9999	1000000:1	
Sel. 24-5	15.5	0.9989	908:1	6
Group III				
Sel. 24-7	16.3	0.9999	1000000:1	
Sel. 28-3	15.2	0.6628	2:1	
Sel. 29-17	15.7	0.9960	249:1	
Sel. 31-4	15.3	0.7517	3:1	
Sel. 32-14	15.9	0.9999	100000:1	
Sel. 32-15	15.8	0.9994	1666:1	
Sel. 34-5	15.5	0.9616	25:1	
Sel. 37-8	16.0	0.9999	100000:1	
Sel. 37-12	16.6	0.9999	1000000:1	
Sel. 40-7	15.6	0.9864	73:1	
Sel. 40-19	15.1			
All selections	15.5			
Inbred	15.7			
F_1 hybrid	15.7			
SLC 15 BB_2	15.0			
SLC 15 BB_1	14.9			

1/ Recurrent selections made only from progeny lines superior for both characters.

The experiment is not designed to provide a study of the variances, because there are insufficient numbers in the progeny lines and randomization is inadequate. However, the within-plot total and genetic variances were calculated to provide a basis for possible trends. These variances are not tabulated but some general observations were noted. The roguing of the SLC 15 BB_1 population for the monogerm character would appear to have reduced the genetic variability in the resulting monogerm population (SLC 15 BB_2). The genetic variances of the selections are generally lower than that of the parent material from which they were selected (SLC 15 BB_2).

Weight per root

In table 2 are the probabilities and odds that the 33 progeny lines are superior to the population SLC 15 BB_2 from which they were selected. It will be noted that there is only one selection with odds greater than 99:1 of being superior to SLC 15 BB_2 for weight per root. There are only four with odds greater than 19:1 and 12 with odds of 5:1 or greater. These probabilities were again calculated within groups. These results would indicate that improvement of weight per root has not been general nor extensive among the selected progeny lines.

Table 2 Means, probabilities, and odds that progeny lines are better than the parent material from which they were selected; weight per root.

Progeny line or population	Mean	Probability	Odds
	kg.		
Group I			
Sel. 3-6	1.0655	0.7764	3:1
Sel. 3-15	1.1195	0.9345	14:1
Sel. 5-8	1.0675	0.7823	4:1
Sel. 5-16	1.1795	0.9893	92:1
Sel. 6-4	1.0525	0.7157	3:1
Sel. 6-16	1.1130	0.9222	12:1
Sel. 6-17	1.0660	0.7764	3:1
Sel. 7-11	1.0840	0.8461	5:1
Sel. 7-17	0.9950		
Sel. 7-18	1.0390	0.6443	2:1
Sel. 8-3	1.3215	0.9999	1000000:1
Group II			
Sel. 8-8	1.1230	0.7549	3:1
Sel. 8-19	1.1115	0.7054	2:1
Sel. 9-11	1.1855	0.9357	15:1
Sel. 9-19	1.1045	0.6700	2:1
Sel. 11-5	1.1140	0.7157	3:1
Sel. 13-19	1.2435	0.9878	81:1
Sel. 14-1	1.2015	0.9582	23:1
Sel. 14-12	1.1880	0.9394	16:1
Sel. 21-7	1.1135	0.7157	3:1
Sel. 22-9	1.0945	0.6179	2:1
Sel. 24-5	1.1425	0.8315	5:1
Group III			
Sel. 24-7	1.1320	0.7357	3:1
Sel. 28-3	1.1940	0.9265	13:1
Sel. 29-17	1.1125	0.6443	2:1
Sel. 31-4	1.1580	0.8365	5:1
Sel. 32-14	1.0825		
Sel. 32-15	1.0320		
Sel. 34-5	1.1010	0.5832	1:1
Sel. 37-8	1.1295	0.7257	3:1
Sel. 37-12	1.0955	0.5517	1:1
Sel. 40-7	1.0900	0.5199	1:1
Sel. 40-19	1.1165	0.6628	2:1
All selections	1.1203		
Inbred	0.6703		
F_1 hybrid	1.0868		
SLC 15 BB_2	1.0578		
SLC 15 BB_1	1.0930		

As in percentage sucrose the within-plot total and genetic variances are not highly reliable. Although these variances are not tabulated, they were calculated to detect possible trends. It is of interest to note that contrary to the results under percentage sucrose there apparently has not been a general reduction of the total within-plot variances, due to selection. Thus it would seem that the selection practices have not affected the means nor have they greatly affected the variances for weight per root. A much more complete evaluation of these relationships will be made in the 1963 population genetics study of this material.

Percentage sucrose and weight per root

In considering these characters simultaneously there are only two progeny lines which have odds greater than 19:1 for both characters of being superior to the parental material from which they were selected. These were selections 13-19 and selections 14-1. This, however, corresponds quite well with the results outlined in the 1960 Report when the population SLC 15 BB_2 was partitioned and genetic gains were predicted. In that report it was stated ". . . approximately two individuals per ten thousand would be expected to fall into classes that would make them identifiable as genetically superior for both characters". Hence, of the approximately 9,600 roots from which these progeny lines were selected, two have been demonstrated to be genetically superior based on the performance of their progeny.

In order to choose the seven best progeny lines for use in further studies it was necessary to accept odds as low as 4:1 for one or the other character.

Root weight has been difficult to shift in the first selection but this is not surprising. In the 1959 selection of the parents of these progeny lines, 800 roots were selected on the basis of root weight from a population of about 9,600. These selections were made using Powers (1) method of selection from small units. After analysis, 200 roots were selected from these 800 on the basis of percentage sucrose. The probabilities were calculated for each of these roots being superior to the parental population. Considering both characters simultaneously, there were 47 roots with odds greater than 60:1 that they were truly superior to the material from which they were selected. As stated previously, the 33 progeny lines in this study are those of the original 47 which survived and produced sufficient seed to be tested.

This selection program appears to have increased percentage sucrose in the progeny lines but at the same time appears to have reduced the genetic variability. The mean for all progeny lines is 15.55 percent compared to 14.97 percent for SLC 15 BB_2. This difference is significant at the one-percent level. This same selection program appears to have

had little effect on weight per root. The mean for all progeny lines is 1.12 kilograms compared to 1.06 for SLC 15 BB_2. This difference is not significant at the five-percent level. The variability for all progeny lines appears to be little different from the parent population.

Selections were made from the seven superior progeny lines in this polycross progeny test with the greatest selection pressure being applied to weight per root. The populations developed from these "recurrent" selections will also be included in the 1963 study. These populations will be a synthetic from 42 roots selected from the seven superior progeny lines and a synthetic of the five best roots from the same superior progeny lines. The 42 were the survivors of 46 roots which had odds of 5:1 or greater of being superior to their original parental material (SLC 15 BB_2) for both weight per root and percentage sucrose. The five most superior roots had corresponding odds of 79:1 or greater for weight per root and 59:1 or greater for percentage sucrose. These five were included in the 42 and also self pollinated in single plant isolations by dividing each of the five roots into three sections. The 42 roots represented all seven superior progeny lines with from two to nine roots coming from each line,as is shown in table 1. The five most superior roots came from four progeny lines.

Some selfed seed and stem cuttings have been obtained from each of the progeny lines. Populations developed from these sources will also be tested in the 1963 population genetics study.

The relationships of mean and variance and measures of genetic shift will be examined more extensively in a population genetics study which will incorporate six populations resulting from different methods of selection and breeding, all having been derived from the same parental population.

Summary

This polycross progeny test of 33 progeny lines from a genetically broad-base monogerm sugarbeet population resulted in the selection of seven progeny lines for further breeding studies. These seven lines had odds of 4:1 or greater for both characters, being superior to the parental material from which they were selected. From these seven progeny lines, 46 roots were selected which had the greatest odds of being superior for both weight per root and percentage sucrose.

The original selection of these 33 progeny lines appears to have increased the mean percentage sucrose above the parental material but at the same time reduced the variability. For weight per root the mean and variability appear to have undergone little change.

Literature Cited

(1) Powers, L. 1957. Identification of genetically superior individuals and the prediction of genetic gains in sugar beet breeding programs. Jour. Amer. Soc. Sugar Beet Technol. IX(5): 408-432.

PART VII

POLYPLOIDY IN RELATION TO ROOT YIELD, SUCROSE PERCENTAGE, AND DISEASE RESISTANCE

- - -

INTERSPECIFIC HYBRIDIZATION and STUDIES ON TETRAPLOIDY

Foundation Project 11

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POLYPLOIDY IN SUGARBEETS

Combining Ability in Diploid, Triploid, and Tetraploid Male-Sterile Monogerm Hybrids

V. F. Savitsky

Diploid and tetraploid equivalents of several varietal populations, inbred lines, and tetraploid hybrids were used in a study of the combining ability in diploid, triploid, and tetraploid hybrids.

The experimental tests were conducted at Spence field near Salinas, California. Natural infection by virus yellows occurred at an early stage of growth and was so severe over the whole field that it may be considered that 100 percent of all populations became affected.

Materials and Methods

Study of combining ability was performed in two separate experiments planted simultaneously in the same field.

In the first experiment, with 12 replications in a randomized block design, the following diploid populations and corresponding tetraploids were studied:

1. Diploid US 35/2, a curly-top-resistant variety, and tetraploid S-040 which was obtained from several reproductions of tetraploid US 35/2.
2. Diploid US 104, a curly-top-resistant variety, and tetraploid S-060 which was obtained after several reproductions of tetraploid US 104.
3. Diploid US 401, a leaf-spot-resistant variety, and tetraploid S-025 which was obtained after reproductions of tetraploid US 401.
4. Diploid SLC 15 and tetraploid SLC 15, monogerm self-sterile populations.
5. Diploid SLC 91 and tetraploid SLC 91, monogerm self-fertile inbred lines.

For all varieties and strains studied, the diploid and tetraploid parental populations, diploid and tetraploid F_1's, and two triploid hybrids were tested. The triploid hybrids were obtained from the hybridization of a 2n male-sterile strain with a tetraploid pollinator, and also from the hybridization of a 4n male-sterile strain with a diploid pollinator. Hybridization of male-sterile monogerm strains was conducted in separate isolations with diploid and with tetraploid pollinators.

In the second experiment, in which 10 replications were arranged in a randomized complete block design, F_1 monogerm male-sterile hybrids derived from hybridization with the high sucrose tetraploid strain S-203 and certain other diploid and tetraploid strains were studied.

Both experiments were planted April 10 and harvested October 26, 1962. The previous crop was barley. Fertilization consisted of 900 pounds 10-10-5 per acre as preplant and two side dressings of 200 pounds of 16-20 per acre. Single-row plots were used and the plots were spaced 28 inches apart. Irrigations were applied at 10-day intervals by furrows from time of planting. Plants were sprayed to control leaf miner. No bolting or curly top damage was observed in the experiments.

Experimental results

Soon after thinning and during the remaining growth period, it was observed that many triploid and tetraploid populations had exceptionally good vigor. Some, in addition to good vigor, had greener foliage than the diploid varieties. This was especially true of tetraploid US 35/2 and tetraploid US 104.

Yield and percent sucrose in diploid and tetraploid parental strains

Table 1 shows the yield and percent sucrose in the diploid and tetraploid colchicine induced populations.

All tetraploid populations had higher yield than the original diploids. However, a significant increase in yield was obtained for only two curly top resistant populations US 35/2 and US 104.

Tetraploid US 35/2 showed a higher yield than any diploid variety in this experiment. Percent sucrose in the tetraploid US 35/2 significantly exceeded the percent sucrose of its original diploid.

In earlier experiments in Salt Lake City, Utah, the tetraploid population of US 35/2 always yielded more than the US 35/2 diploid population, but increase in yield, as well as the changes in percent sucrose, was not significant statistically. (See 1960 Report Part IV.)

Increase in root yields of tetraploid US 104 and tetraploid US 401 was greater than that of their respective diploid ancestors, in experiments conducted at Salt Lake City in 1960.

In the test at Salinas the yields of roots of the diploid and tetraploid phases of the self-fertile monogerm inbred SLC 91 and also of self-sterile monogerm SLC 15 were similar or statistical differences were not demonstrated.

Diploid monogerm male-sterile top cross hybrids. Diploid monogerm F_1 hybrids, obtained from crosses of SLC 91 with 3 multigerm populations (US 35/2, US 104, and US 401), significantly surpassed the inbred line SLC 91 in yield, but the hybrids did not surpass significantly their respective pollinator; i.e., the open-pollinated varieties in either yield of roots or percent sucrose (Table 2).

Tests of these F_1 hybrids in both Salt Lake City and Salinas showed that the diploid F_1 monogerm male-sterile hybrids gave the same, or a little higher yield, that the multigerm varieties, although these differences were usually not significant.

When diploid monogerm male-sterile beets were crossed to the monogerm diploid strain, the yield of F_1 hybrids was a little lower than that of the pollinator. Similar nonsignificant reduction in yield of this F_1 diploid hybrid was obtained in Salt Lake City. Monogerm male-sterile SLC 91 and monogerm self-sterile SLC 15 are related strains. The multigerm pollinator differs genetically from the monogerm male-sterile beets and, therefore, the hybrids between them were more productive.

Triploid monogerm male-sterile hybrids. Ten triploid hybrids were tested in this experiment (Table 3).

All triploids were higher in yield than their corresponding diploid parent. They were also higher in percent sucrose. However, a significant increase over diploid open-pollinated varieties was recorded only for the triploid combination derived from US 35/2.

Under Salinas conditions, triploids derived from crosses with the curly-top-resistant variety US 35/2 yielded especially well and sucrose percent was high.

It should be noted that in this experiment the reciprocal triploid hybrids showed different yield. With one exception, higher yields were obtained from triploids derived from pollination with diploid gametes; i.e., when the pollinator was tetraploid. This was observed in hybrids with US 35/2, US 401, and US 104. It is probable that the diploid gametes produce a higher genetical diversity, and a higher degree of

heterozygosity in the triploid hybrids, which leads to a more marked expression of heterosis. If the diploid gametes are transferred from the heterozygous open-pollinated population, they produce more diverse alleles in the triploid hybrids than the diploid gametes of an inbred line.

In general, the F_1 triploid male-sterile monogerm hybrids appeared to produce higher yield than the corresponding F_1 diploid topcross hybrid (Table 4). However, the diverse triploid hybrid combinations differed in the grade of superiority over the F_1 diploid hybrids. The greatest effect was recorded for the hybrids derived from pollinations with US 35/2, US 104, and SLC 15. These triploids also showed higher sucrose, although the increase in percent sucrose was not significant.

F_1 tetraploid and F_1 diploid monogerm male-sterile hybrids. In the 1962 experiment conducted in Salinas, the tetraploid populations grew better and yielded more than their diploid ancestors (Table 1). This was true also of the tetraploid hybrids, which often exceeded in yield and in percent sucrose the open-pollinated diploid varieties and also their F_1 diploid hybrids (Table 5). Two tetraploid hybrids (with US 35/2 and US 104) were significantly higher in yield than the corresponding F_1 diploid hybrids. These differences between F_1 diploid and tetraploid hybrids are caused by a specific reaction of tetraploids under Salinas conditions. Better evaluation of tetraploid strains was obtained in Salinas than in Salt Lake City. Differences are clearly expressed in the two curly-top-resistant varieties US 35/2 and US 104. These varieties and their triploid and tetraploid hybrids were especially

vigorous during the entire summer. They had greener foliage and they were apparently less affected by virus yellows than other varieties.

Data obtained during one year do not permit a final conclusion, but is seems probable that the tetraploid populations of US 35/2 and US 104 contain many biotypes with higher tolerance to virus yellows than tetraploid populations of other varieties. If this is true, the higher yellows tolerance may be responsible for higher yields and for higher percent sucrose in the tetraploid populations and in their tetraploid and triploid hybrids. It is possible that tetraploids, and especially the American curly-top-resistant varieties, represent the most valuable material for breeding for virus yellows resistance.

It might be mentioned that doubling of chromosomes increases resistance to curly top in many diploid genotypes and that polyploidy appears as a factor which changes genetically the resistance to a virus disease.

<u>Top cross monogerm male-sterile di-tri-and tetraploid hybrids derived from high sugar open-pollinated varieties</u>. It is of great importance to obtain information about the possibility of increasing sucrose content of sugarbeet varieties. One way of increasing sucrose content may consist of obtaining monogerm male-sterile hybrids with two genomes derived from a parent high in sugar and one genome from a monogerm beet. The monogerm strain may carry the valuable dominant genes (such as genes controlling resistance to diseases). Yield can be increased by heterosis, often observed in the triploid hybrids. Only those tetraploid pollinators should be used which are high in sugar and which produce triploid hybrids with high percent sucrose. For this purpose

a tetraploid strain, S-203, was produced by H. Savitsky by colchicine treatment of the diploid high sugar variety Janasz. The strain S-203 is composed of seed obtained from about 60 tetraploid plants selected in the C_1 generation for vigor of seedlings, first year beets and seed beets. C_2 seeds were harvested individually from the best C_1 plants. It was observed during this summer that the strain S-203 had good vigor. This strain is also a good pollen producer; therefore, it can be reproduced as easy as any diploid self-sterile strain.

Under test, strain S-203 had 16.89% sucrose, whereas the diploid US 75 had only 14.40% (LSD 5% point equals 0.8). The tetraploid S-203 also had a little higher percent sucrose (16.55%) than its diploid ancestor, var. Janasz (Table 6).

The diploid F_1 hybrid derived from 2n MS mm x 2n Janasz had 16.02% sucrose. Percent sucrose in this hybrid was significantly lower than that in the tetraploid S-203 but significantly higher than that in diploid US 75.

The tetraploid monogerm F_1 male-sterile hybrid derived from S-203 showed yield and percent sucrose equal to or a little higher than the F_1 diploid hybrid between a diploid monogerm male-sterile strain and diploid Janasz.

The triploid monogerm male-sterile hybrid derived from hybridization of the diploid monogerm male-sterile strain with tetraploid S-203 had 16.49% sucrose, which was 2 percentage points higher than the diploid variety US 75. This triploid hybrid also surpassed significantly the diploid US 75 check in tonnage.

A triploid hybrid obtained from a cross of a diploid monogerm male-sterile strain with a tetraploid strain low in sugar was tested in the

same experiment. Sucrose in this triploid equaled 11.35%. Sucrose in triploid hybrids in the experiment ranged from 11.35% to 16.49% and the average sucrose in commercial sugarbeet varieties was about 14.40%.

There was a wide range in sucrose percent among populations under Salinas conditions where the beets were severely affected by virus yellows. The level of sucrose content under conditions of severe virus yellows infection is very strongly influenced by the genetic part of the general variability of sucrose content. The polyploid hybrids open new possibilities for increase of percent sucrose under California conditions.

Sucrose in the diploid sugarbeet tester (S-155) and in its F_1 hybrids. S-155 is a sugarbeet diploid, self-sterile, multigerm population with red petioles (a dominant character) and white roots. Percent sucrose and root yield in this strain was as follows:

	Percent sucrose	Tons of beets
S-155 (parent)	15.6*	9.54
F_1 (2n MS mm x S-155)	15.2*	11.11
US 75, diploid multigerm	14.4	10.22

* Exceeds significantly US 75 at 5% point.

The relatively high percent sucrose in the strain S-155 and the increase in tonnage and percent sucrose in its F_1 hybrids indicate that the strain may be useful as a pollinator in determination of combining ability for increased percent sucrose and tonnage in sugarbeets.

Pigmentation of petioles and of stems in the S-155 is caused by the gene R^p, a member of the multiple allele R. Heterozygotes for this gene are well recognizable in summer and at harvest. Pigmentation of petioles of cotyledons is not often sufficient to be used at thinning. To increase the percent of hybrids, pollinator (S-155) may be planted in double or triple amount in comparison with the tested line.

Table 1. --- Diploid and tetraploid colchicine induced populations.

	Tons of roots			Percent sucrose		
	Diploid	Tetraploid	Difference	Diploid	Tetraploid	Difference
SLC 91 monogerm self fertile	9.2220	9.6107	+ 0.3887	13.2250	13.5083	+ 0.2833
SLC 15 monogerm self sterile	11.5540	12.7200	+ 1.1660	13.3083	14.1750	+ 0.8667
US 35/2	10.1760	16.4653	+ 6.2893	12.4750	14.0417	+ 1.5667
US 104	12.2607	14.5220	+ 2.2613	12.9583	13.2750	+ 0.3167
US 401	12.0133	13.5680	+ 1.5547	13.1167	13.4083	+ 0.2916
LSD at 5% point			2.1885			1.0449

Table 2.—— F_1 diploid hybrids between MS 91 and monogerm and multigerm populations. Salinas, 1962.

	Tons of roots			Percent sucrose		
	Diploid parents and $\frac{P_1 + P_2}{2}$ 1/	Diploid F_1	Difference	Diploid parents and $\frac{P_1 + P_2}{2}$ 1/	Diploid F_1	Difference
SLC 15 monogerm	a: 9.2220	11.1653	+ 1.9433	13.2250	13.6917	+ 0.4667
	b: 11.5540		- 0.3887	13.3083		+ 0.3834
	c: 10.3830		+ 0.0773	13.2667		+ 0.4250
US 35/2	a: 9.2220	11.8013	+ 2.5793	13.2250	13.4667	+ 0.2417
	b: 10.1760		+ 1.6253	12.4750		+ 0.9917
	c: 9.6990		+ 2.1023	12.8500		+ 0.6167
US 104	a: 9.2220	12.4373	+ 3.2153	13.2250	12.6833	- 0.5417
	b: 12.2607		+ 0.1766	12.9583		- 0.2750
	c: 10.7414		+ 1.6959	13.0917		- 0.4084
US 401	a: 9.2220	13.4267	+ 4.2047	13.2250	13.8250	+ 0.6000
	b: 12.0133		+ 1.4134	13.1167		+ 0.7083
	c: 10.6177		+ 2.8090	13.1708		+ 0.6542
LSD at 5% point			2.1885			1.0449

1/ a: P_1 2n SLC 91

b: P_2 pollinators

c: $\frac{P_1 + P_2}{2}$

Table 3.--- Monogerm triploid MS hybrids and diploid ancestors.
Salinas, 1962.

	Tons of roots			Percent sucrose		
	Diploid	Triploid F_1 1/	Difference	Diploid	Triploid F_1 1/	Difference
SLC 91 monogerm	9.2220	a: 11.8013 b: 10.9533	+ 2.5793 + 1.7313	13.2250	a: 14.1917 b: 13.6917	+ 0.9667 + 0.4667
SLC 15 monogerm	11.5540	a: 12.8967 b: 13.2500	+ 1.3427 + 1.6960	13.3083	a: 13.7917 b: 13.9333	+ 0.4834 + 0.6250
US 35/2	10.1760	a: 15.6173 b: 13.5680	+ 5.4413 + 3.3920	12.4750	a: 13.8583 b: 14.0250	+ 1.3833 + 1.5500
US 104	12.2607	a: 14.4160 b: 13.8860	+ 2.1553 + 1.6253	12.9583	a: 13.5333 b: 13.4167	+ 0.5750 + 0.4584
US 401	12.0133	a: 14.1687 b: 13.8154	+ 2.1554 + 1.8021	13.1167	a: 13.4417 b: 13.4333	+ 0.3250 + 0.3166
LSD at 5% point			2.1885			1.0449

1/ a: monogerm diploid MS SLC 91 x tetraploid pollinator.

b: monogerm tetraploid MS SLC 91 x diploid pollinator.

Table 4.--- Monogerm F_1 triploid and diploid MS hybrids. Salinas, 1962.

	Tons of roots			Percent sucrose		
	Diploid F_1	Triploid F_1 1/	Difference	Diploid F_1	Triploid F_1 1/	Difference
SLC 91 monogerm	9.2220	a: 11.8013 b: 10.9553	+ 2.5733 + 1.7333	13.2250	14.1917 13.6917	+ 0.9667 + 0.4667
SLC 15 monogerm	11.1653	a: 12.8967 b: 15.2500	+ 1.7314 + 2.0847	13.6917	13.7917 13.9333	+ 0.1000 + 0.2416
US 35/2	11.8013	a: 15.6173 b: 13.5680	+ 3.8160 + 1.7667	13.4667	13.3583 14.0250	+ 0.3916 + 0.5583
US 104	12.4373	a: 14.4160 b: 13.8860	+ 1.9787 + 1.4487	12.6833	13.5333 13.4167	+ 0.8500 + 0.7334
US 401	13.4257	a: 14.1637 b: 13.8154	+ 0.7420 + 0.3887	13.8250	13.4417 13.4333	- 0.3833 - 0.3917
LSD at 5% point			2.1885			1.0449

1/ a: monogerm diploid MS SLC 91 x tetraploid pollinator.

b: monogerm tetraploid MS SLC 91 x diploid pollinator.

Table 5.--- F_1 diploid and F_1 tetraploid monogerm hybrids. Salinas, 1962.

	Tons of roots			Percent sucrose		
	Diploid F_1	Tetraploid F_1	Difference	Diploid F_1	Tetraploid F_1	Difference
SLC 15 monogerm	11.1653	11.5307	+0.3654	13.6917	13.6167	-0.0750
US 35/2	11.8013	14.7693	+2.9680	13.4667	14.3500	+0.3333
US 104	12.4373	14.6633	+2.2260	12.6833	13.8533	+1.1750
US 401	13.4267	13.9567	+0.5300	13.3250	14.0750	+0.2500
LSD at 5% point			2.1835			1.0449

Table 6.--- Percent sucrose and yield in F_1 di-tri-and tetraploid monogerm MS hybrids derived from high sugar strain S-203.

Populations	Ploidy level	Percent sucrose	Tons of beets
Parents:			
Diploid Janasz	2n	16.55 **	9.5824
Tetraploid S-203	4n	16.89 ** *	11.9568
Difference		0.34	2.3744
F_1 hybrids:			
2n MS monogerm x 2n Janasz	2n	16.02 **	10.8968
4n MS monogerm x 4n S-203	4n	15.92 **	11.9568
2n MS monogerm x 4n S-203	3n	16.49 **	13.4832**
Check:			
US 75 open-pollinated variety	2n	14.40	10.2184

**/ Exceeds significantly US 75 at 5% point.

*/ Exceeds significantly F_1 diploid and F_1 tetraploid monogerm MS hybrids.

CURLY TOP AND LEAF SPOT RESISTANCE IN TETRAPLOID SUGAR BEET STRAINS.

by V.F.Savitsky, Helen Savitsky, J.O.Gaskill, and Albert M.Murphy

The leaf spot resistant diploid population US 401 was severely infected by curly top in Salt Lake City in 1958 and the grade[1/] of its curly top resistance equaled 7.8979 ± 0.09008.

In the same experiment the grade of curly top resistance of its equivalent, tetraploid US 401, obtained by H.Savitsky by colchicine treatment and propagated 2 times (C_2), was much higher and equaled 2.0442 ± 0.00689.

The yield of the roots of the diploid population US 401 was greatly reduced by curly top in this experiment, while the average yield of the tetraploid US 401 population equaled the yield of the diploid curly top resistant variety US 35/2.

Resistance to curly top under the influence of chromosome doubling was unknown until discovered by V.F.Savitsky in the experiment in Salt Lake City, hence, it was desirable to obtain information concerning the variability of curly top resistance in the following generations of the tetraploid US 401, in different lines derived from tetraploid 401 and in the hybrids obtained from this strain. Experiments conducted over several years showed that the increase in tetraploid US 401 resistance to curly top in comparison with the original diploid variety was not reduced in the following generations, as demonstrated when the tests were conducted under severe curly top conditions.

1/ Grades of severity of disease symptoms in this report based on a numerical system of 1-10, inclusive, in ascending order of severity.

Table 1. Curly top resistance in diploid and tetraploid US 401.

Year	Location of test	Resistance to curly top in			
		US 401 diploid	US 401 tetraploid	US 35/2 diploid	Klein diploid
		curly top grades			
1958	Salt Lake City,Utah	8	2	1	10
1959	Jerome,Idaho	10	6.5	5.5	10
1960	Jerome,Idaho	8	5.5	4.5	9
1961	Jerome,Idaho	8	5.4	4.5	9
1962	Thatcher,Utah	8.5	5	2.0	9.5

The grade of curly top resistance in the tetraploid population of US 401 was much higher than in the diploid.The tetraploid population of US 401 is less resistant to curly top than the highly resistant diploid variety US 35/2 in only 1 or 2 classes, while the diploid population of US 401 is less resistant than US 35/2 in 4 or 5 classes,practically placing it in the group of susceptible curly top varieties.

For evaluation of US 401, it is very important to establish whether its grade of resistance to leaf spot was changed in comparison with the original diploid variety US 401. From practical breeding in diploid beets, it is known that after selection for sucrose or leaf spot resistance, the grade of resistance to curly top is often reduced.

To make use of tetraploid 401 in breeding program, it is important to know the grade of modification of curly top and leaf spot resistance in individual lines derived from the tetraploid US 401 and the grade of varia-

tion of leaf spot resistance in the hybrids between tetraploid 401 and other leaf spot susceptible tetraploids. For this purpose,different lines were selected from a tetraploid population US 401. Some of these lines were resistant to curly top,some were resistant to leaf spot, and some were selected for vigor or other agronomic characters.Tetraploid lines were distinguished by good vigor.Tetraploid 401 was also crossed to other tetraploids and hybrid generation (F_4-F_5) were obtained without selection for leaf spot or curly top resistance.

Available material permitted a test of 29 tetraploid lines for leaf spot and curly top resistance in 1962. For better evaluation in the experiment, the following varieties were included: the diploid variety US 401, the leaf spot resistant multigerm inbred US 201 (leaf spot reading equals 1.5), the highly leaf spot resistant monogerm inbred S-23 (leaf spot reading equals 1.0), and a susceptible European leaf spot variety.

A test for leaf spot resistance was performed by J.O.Gaskill in Fort Collins,Colorado,in 1962. Planting was done in a 2-row plot,randomized block design,in 3 replications.Artificial inoculation and frequent sprinkling were employed to promote development of leaf spot. The August 27 readingswere made at the approximate peak of the second week of the epidemic.

Test for curly top resistance was made by A.M.Murphy at Thatcher, Utah.Tetraploid lines were randomized in single-row plots (50 feet long).The curly top exposure was increased by planting of test populations and planting susceptible beets (Klein) about 2 months earlier.

Virulent strains of curly top virus were introduced by transplanting diseased beets selected the previous year. Reading of curly top severity was made by V.F.Savitsky September 11-14.Each plot obtained a general evaluation; readings were taken also on all individual plants in all the plots.The curly top infection was moderately heavy this year, as indicated by the fact that the US 33 check showed 100% infection by September 1.

Evaluation of tetraploid lines selected for leaf spot resistance.

Seven tetraploid lines (code N S-62-1 to code N S-62-7) represent the offsprings of plants selected by J.O.Gaskill for leaf spot resistance in Fort Collins in 1960.The beets selected were transferred to Salinas,California,where,after control of chromosome numbers, they were used for seed production in 1961. The following table represents the results of evaluation of these lines in leaf spot and curly top resistance in 1962.

Table 2. Curly top and leaf spot resistance of tetraploid lines selected for leaf spot resistance in tetraploid US 401

Location and kind of test	Lines And Varieties										
	1	2	3	4	5	6	7	US401 2n	US401 4n*	US35/2 2n	Klein 2n
	Grades Of Severity										
Curly top res. in Thatcher	7	5	3	7	5	5.5	7	8.5	5	2	9.5
Leaf spot res. in Fort Collins	3	3	2.5	3	3.5	3.3	2.8	3	3.7	suscept.	5

*/4n US 401 S-62-21

All 7 tetraploid lines showed a higher grade of leaf spot resistance than the original tetraploid population,US 401 (code N S-62-21).Five of these lines were not lower in leaf spot resistance than the original diploid US 401.

All these lines appeared more resistant to curly top than the original diploid variety US 401.Four of 7 of these lines showed the same grade of curly top resistance as the tetraploid US 401. One line (S-62-3) proved to have good resistance to both diseases.

Thus,after selection for leaf spot resistance,many tetraploid lines retained their resistance to curly top.

The yield of the diploid US 401 was greatly reduced by curly top in the experiment conducted in Utah in 1962. The majority of tested tetraploid US 401 lines were not lower in tonnage nor in foliage development than the diploid variety US 35/2.

Evaluation of tetraploid lines selected for curly top resistance.

Selections for curly top resistance were made from a tetraploid population US 401 by V.F.Savitsky in Salt Lake City in 1958. The selected lines were propagated twice. At the time of selection for curly top resistance, leaf spot infection was not observed in Salt Lake City. Evaluation of these lines for curly top and leaf spot resistance is shown in table 3.

Table 3. Curly top and leaf spot resistance of totraploid lines selected for curly top resistance in tetraploid US 401

Location and kind of test	Lines And Varieties											
	22	23	24	25	26	27	28	29	US401 2n	US401 4n	US35/2 2n	Klein 2n
	Grades Of Severity											
Curly top res. in Thatcher	4	4	5	5	3	5	4	5	8.5	5	2	9.5
Leaf spot res. in Fort Collins	3.0	3.5	3.7	3.8	3.3	2.5	3.2	2.8	3.0	3.7	suscep.	5.0

Selection for curly top resistance gave lines with higher curly top resistance than the original tetraploid population US 401,and no line showed

lower resistance than the original tetraploid population.

At the same time, the tetraploid lines were higher in leaf spot resistance than the original tetraploid population of US 401, and 4 lines showed approximately the same grade of resistance to leaf spot as the diploid US 401.

Evaluation of tetraploid lines selected in the absence of curly top and leaf spot infection.

Seven lines obtained from plants selected in the tetraploid population US 401 for vigor, weight of roots, and dry matter, were evaluated for resistance to curly top and leaf spot. Selections were made, in this case, under conditions where curly top and leaf spot infection were not observed.

Table 4. Evaluation of tetraploid lines selected for vigor and dry matter in a tetraploid population US 401.

Location and kind of test	Lines And Varieties										
	8	9	10	11	12	13	14	US401 2n	US401 4n	US35/2 2n	Klein 2n
	Grades Of Severity										
Curly top res. in Thatcher	6	5.5	5	5	6	5	7	8.5	5	2	9.5
Leaf spot res. in Fort Collins	3	3.5	3	2.3	3.2	3.3	2.5	3	3.7	suscep.	5.0

These hybrids showed diversity in resistance to curly top and leaf spot. Among them 2 lines appeared with high resistance to leaf spot, and no line had lower resistance to leaf spot than the tetraploid population US 401.

Evaluation of F_4 tetraploid hybrids for leaf spot and curly top resistance.

A tetraploid monogerm self-sterile strain with average resistance to curly top and high susceptibility to leaf spot was crossed with tetraploid US 401.

F_1 hybrids were determined by the characters of fruit (F_1 plants had multigerm fruits). All of these hybrids carried 2 genomes of leaf spot resistant US 401 parent and 2 genomes of monogerm self-sterile strain with average resistance to curly top. The following hybrid generations were selected for neither leaf spot nor curly top resistance, nor for any other character. Six lines of the fourth generation hybrids (F_4) were tested for curly top and leaf spot resistance in 1962.

Table 5. Evaluation of curly top and leaf spot resistance in tetraploid F_4 hybrids from crosses of tetraploid monogerm strain to tetraploid US 401

Location and kind of test	Lines And Varieties									
	15	16	17	18	19	20	US401 2n	US401 4n	US35/2 2n	Klein 2n
	Grades Of Severity									
Curly top res. in Thatcher	2.5	2	2.5	4	3	3	8.5	5	2	9.5
Leaf spot res. in Fort Collins	3.2	3.3	3.8	3.5	3.3	3.2	3.0	3.7	suscept.	5

It is obvious that resistance to curly top increased in the hybrid lines in comparison to tetraploid US 401, and especially in comparison to the diploid US 401. Some of the hybrids were highly resistant to curly top.

The hybrids which were highest in leaf spot resistance were graded 3.2 and 3.3,whereas the tetraploid US 401 was graded 3.7.Only one of these hybrids was lower in resistance (3.8) than the original tetraploid US 401.The grade of leaf spot resistance in the tetraploid hybrids was not significantly different from that of diploid US 401 (3.0).

Evaluation of tetraploid lines with the best combination of leaf spot and curly top resistance.

The grades of curly top and leaf spot resistance in 6 tetraploid lines are shown in the table 6. Four of these lines were obtained after selection in tetraploid population of US 401. Two lines derived from propagation of tetraploid hybrids with 2 genomes of US 401 and 2 genomes of the monogerm self-sterile strain.

Table 6. Expression of the combined resistance to curly top and leaf spot in the produced tetraploid lines

Lines And Varieties	Resistance to: Curly Top	Resistance to: Leaf Spot
	Grades Of Severity	
2n US 401 (population)	8.5	3
4n S-62-3 (line from US 401)	3	2.5
4n S-62-27 (line from US 401)	5	2.5
4n S-62-26 (line from US 401)	3	3.3
4n S-62-11 (line from US 401)	5	2.3
4n S-62-16 (F_4 hybrid)	2	3.3
4n S-62-15 (F_4 hybrid)	2.5	3.2

Summary.

Selection for curly top and leaf spot resistance,and for vigor in the tetraploid popluation of US 401, gave new tetraploid lines in which leaf spot and curly top resistance were combined on a higher level than in the original diploid population US 401.

Method of combining 2 genomes of a leaf spot resistant parent and 2 genomes of curly top resistant parent appeared to be a valuable method in ob-

taining hybrids which combine resistance to both diseases on the level at which this resistance was present in both parents used in hybridization. Such a combination of resistance to both diseases has been maintained in some tetraploid hybrids by propagation during 4 generations.

PRODUCTION OF TETRAPLOID STRAINS

by Helen Savitsky

Three strains - 1 curly top resistant monogerm inbred line, and 2 nematode resistant strains which have been treated by colchicine in 1961, were selected (by the size of pollen grains) for tetraploid plants induced by treatment. The plants with large pollen grains (diploid gametes) were bagged and intercrossed within the strains. Seeds harvested were planted in a greenhouse. In all C_1 seedlings thus obtained, chromosome number will be checked during the winter and tetraploid plants will be selected. The new tetraploid strains will be obtained by propagation within a strain of the selected C_1 tetraploid plants.

Three monogerm inbred lines of different origin, and 3 male-sterile equivalents for them were treated by colchicine this fall. Seedlings affected were selected and grown in a greenhouse. After thermal induction they will be transplanted to the field for selection of plants with diploid gametes.

A study of the influence of different colchicine concentrations on the outline of meiosis in the tetraploid plants has been started on the same material.

INTERSPECIFIC HYBRIDIZATION

The first backcross generation obtained from the F_1 hybrids between Beta vulgaris and the species of the section Patellares.

by Helen Savitsky

Production of backcross seeds from F_1 allotetraploid hybrids between *B. vulgaris* and *B. patellaris* and from triploid hybrids derived from crosses of *B. vulgaris* with *B. procumbens* and *B. webbiana* was continued in 1962. Over a thousand sugarbeet plants were grown to the flowering stage and used as pollinators. Seeds obtained were planted in a greenhouse and over 300 first backcross hybrids were grown for selection of nematode resistance and study of different characters.

Hybrids of the first backcross generation differed strikingly in appearance from the F_1 hybrids (Fig.1 and 2). The F_1 hybrids were annual, tall-climbing plants resembling the wild beets. They did not develop fleshy roots. The characters of wild species were dominant in the F_1 hybrids. The first backcross hybrids looked like sugarbeets. Th developed fleshy roots and the majority of them were biennial. At the same time character of the wild species could be observed in some hybrid plants at different stages of growth. Some of first backcross hybrids were annual and did not develop fleshy roots; some had red pigmentation on the stem and on the petioles received from the wild parent. Some seedlings had very narrow cotyledons like the species of the section *Patellares*, or red spots on the leaves as in F_1 hybrids. A few backcross seedlings did not develop root systems, or they germinated upside down by raising the root over the soil surface and leaving cotyledons in the ground.

Figure 1. Interspecific hybrids between Beta vulgaris and species of the section Patellares.

Figure 2. Plants of first backcross obtained from F_1 hybrids pollinated by sugarbeets.

A study of meiosis in F_1 hybrids showed that the majority of chromosomes of wild species were univalents and remained on the spindle as laggards. Many chromosomes of wild species are eliminated in meiosis. Only segments of chromosomes of the species of the section Patellares and a few entire chromosomes of these species were included in gametes and transmitted to the next generation. Resemblance of the first backcross hybrids to sugarbeet confirmed this observation.

The study of F_1 and backcross generations lead to the following conclusions: (1) It is very important to start the selection for resistance in the first backcross generation rather than in the following generations, because the chromosomes carrying the resistance may be lost very easily; (2) selection for resistance will be more successful in progeny obtained from polyploid hybrids than from diploid F_1 hybrids. The first backcross progeny obtained from polyploid F_1 hybrids is much more vigorous and fertile than the same hybrid generation obtained from the diploid F_1 hybrids. The small number of first backcross hybrid plants that have been obtained from the diploid F_1 hybrids by several other investigators have been practically inviable. Many of them died at different stages of growth, and those that survived to the flowering stage remained almost sterile.

Hybrids of the first backcross generation derived from the polyploid F_1 hybrids contain at least one complete set of chromosomes of the species *Beta vulgaris*, which causes higher viability and fertility of these hybrids. To the set of chromosomes of *B. vulgaris* are added some chromosomes, or segments of chromosomes, of the species of the section *Patellares*.

Further work must be conducted with single chromosomes or segments of chromosomes of wild species, in order to incorporate them in the chromosomes of sugarbeets.

Test for Nematode Resistance in the First Backcross Generation

Helen Savitsky and Charles Price

Seeds of the first backcross generation were obtained by H. Savitsky from F_1 hybrids between *B. vulgaris* and species of the section *Patellares* pollinated by sugarbeets. Seeds were obtained at experimental stations in Salt Lake City, Utah, and Salinas, California.

To increase germination, seeds were scratched on sandpaper and planted by H. Savitsky in soil in the greenhouse. Seedlings in the 2-leaf stage were transplanted in the cyst-infested soil prepared by Charles Price and transplanted to his greenhouse. Hybrid plants were grown by Charles Price during the test period under conditions suitable for development of nematodes.

Sixty days after infestation the hybrid plants were examined for the presence of nematodes on the roots by both investigators. Two hundred and seventy of the first backcross hybrids were tested.

Hybrids heavily infested with nematodes were discarded, and those less affected were graded according to the number of female nematodes on the roots. Those with few nematodes were selected for further tests. To gain confidence in the selections, the plants were grown in nematode-infested soil two more times and examined for the presence of nematodes on the roots. Final selection was made after the third examination. The selected hybrids were divided into two groups. The first group consisted of 15 plants, on the roots of which 1 to 6 females were found. The second group consisted of 9 plants which contained more nematodes than the first group but less than the discarded plants. Not one plant was found to be free of nematodes.

All first backcross hybrids selected for nematode resistance resembled sugarbeets. They developed fleshy roots and only a few were easy bolting.

The selected hybrids were grown in the greenhouse to obtain the next generation and for cytological study. Study of cytological processes is of great importance in the work of transmission of genes from one species to another. On the basis of such a study it is hoped that a way will be found whereby the genes for nematode resistance can be retained and perpetuated in these particular hybrids.

PART VIII

BREEDING FOR NEMATODE RESISTANCE

and

SCREENING TESTS IN FIELD AND GREENHOUSE

Foundation Project 13

Charles Price

PROGRESS REPORT TO THE SUGARBEET DEVELOPMENT FOUNDATION ON BREEDING SUGARBEETS FOR RESISTANCE TO THE CYST NEMATODE *HETERODERA SCHACHTII*

(Foundation Project 13)

Charles Price

The objective of the nematode breeding program at Salinas, California, is to develop breeding lines resistant to the sugarbeet nematode. The urgency of such a program is more evident than it has been in the past because of the spread of the nematode. The practice in California of moving sugarbeet harvesting equipment from field to field and from one district to another increases the possibility of spreading the nematode much more rapidly than when each grower harvested his own beets and the equipment remained on the farm.

Crop rotation is an effective method to combat sugarbeet nematode, but four or five years between beet crops is required. In fields badly infested with nematodes, this practice makes it possible to grow one crop of sugarbeets every four or five years; however, nonsusceptible crops must be grown between beet crops, and weed hosts must be controlled to make crop rotation effective. In California, where nematode susceptible plants of the mustard family such as cabbage, cauliflower, etc. are grown in the rotation, a crop rotation in which these crops are included is ineffective as a control of sugarbeet nematode. A nematode-resistant sugarbeet will reduce the length of time between sugarbeet crops in an effective rotation and also reduce the damage from nematode even in fields in which the nematode infestation is moderate.

Screening tests were continued in the greenhouse at Salinas with a wide range of varieties and breeding lines of sugarbeets. Major emphasis has been placed on lines which have gone through two or three cycles of testing and selection. Lines which have shown promise of resistance to nematode have been crossed with other nematode resistant lines;the progenies were tested in the field under severe exposure to nematodes (Figure 1). Selections have been made from segregating populations derived from these crosses. Greenhouse screening tests are conducted in flats in which nematode cysts and root-rotting fungi have been added to the soil. Root-rotting pathogenes play an important part in the losses of sugarbeets when nematodes are present in the soil, and these pathogenes are present in most soils. Nematodes are undoubtedly responsible, to a large extent, for entrance of root-rotting fungi in beet tissue through punctures made by nematodes. A variety which has resistance to root-rotting fungi is important if losses are to be kept to a minimum. This phase of the breeding work has received much attention. A significant gain in resistance to combination of nematodes and root-rotting fungi has resulted, by means of repeated selections and crosses. To determine the pathogenes involved in the nematode root rot complex, a cooperative experiment with Dr. C. L. Schneider, Pathologist, Crops Research Laboratory, U. S. Department of Agriculture at Logan, Utah, has been initiated.

Greenhouse selections are made on the basis of freedom from nematode cysts on the roots, high vigor, and freedom from rot (Figures 2,3). Sugarbeets grown in the greenhouse are not exposed to virus diseases which attack beets grown in the field. It is desirable, therefore, to

Figure 1. General view of nematode resistance test, U.S. Agricultural Research Station, Salinas, California. The soil in this field is heavily infested with the cyst nematode *Heterodera schachtii* and root-rotting fungi.

Figure 2. Showing difference in size of roots of nematode-resistant line 157-D-3 and US 41. These sugarbeets were grown in the same greenhouse flat of soil heavily infested with the cyst nematode *Heterodera schachtii*.

Figure 3. Sugarbeet seeds planted in greenhouse flats in soil heavily infested with the sugarbeet nematode and containing root-rotting fungi. Commercial variety US 41 and a monogerm line, SL 9229, are highly susceptible. Line 101-7, selected for resistance, shows remarkable resistance.

test greenhouse selections in the field and make selections of segregating populations under exposure to virus diseases. This phase of the work has received attention--not only have lines developed in the breeding program been evaluated, but also, sugarbeets have been selected from commercial fields.

Testing Lines of Sugarbeets for Resistance to Nematode.

The test field at Salinas, California, is on the grounds of the U. S. Agricultural Research Station. The soil in this field is heavily infested with sugarbeet nematode. This was achieved by means of distributing soil containing a high population of nematode cysts uniformly over the field, and planting sugarbeets to build up the population of nematodes. In addition to nematode cysts, root-rotting fungi was added to the soil.

Lines of sugarbeets selected for resistance to nematodes and root rot were planted in randomized replicated plots, using US 41 and US 75 as checks. The damage from nematode and root rot was severe and yields were affected adversely. Field-grown beets were selected from the segregating population, and these selections are being thermally induced for seed increase and hybridization. Yield data are presented in table 1. It is apparent from table 1 that there is a wide difference in yield among the lines. Many of the lines are significantly higher than the checks US 41 and US 75. US 41 has been used consistently in tests for resistance to nematode, and it has been found that while this variety is susceptible to nematode, it is not the most susceptible commercial variety. In comparing lines of sugarbeets resistant to nematode with US 41, there are seven lines significantly better at the 1-percent level and eighteen

lines were significantly better at the 5-percent level. The remaining 29 lines in the test were somewhat higher in yield than US 41, but they did not reach the amounts required for significance.

This test has certain limitations because it was limited to three replications. However, the uniformity of nematode infestation and soil homogeneity tends to increase the reliability of the test.

Testing Breeding Material in Crocks.

In addition to testing and selecting sugarbeets in greenhouse and field for nematode resistance, selected lines were also tested in 3-gallon crocks. The crocks were located outside the greenhouse, and the beets were subjected to all the diseases prevalent in the area during the growing season. The crocks were divided into lots of 20 each. Seeds of each line tested were planted and seedlings thinned to a single plant in each crock. Ten crocks contained nematode-infested soil and ten crocks contained nematode-free soil. There were three such replications, or a total of 30 crocks, for each line in nematode-infested and nematode-free soil. To insure uniformity of soil in each crock, all soil used in the test was thoroughly mixed prior to beginning the test. Nematode-infested soil was added to the crocks in which beets were tested for resistance to nematodes. In an equal number of crocks used as checks, no nematode cysts were added. Cultural practices, fertilization, irrigation, etc., were maintained uniform for all crocks. Beets in the crock test were exposed to yellows and mosaic. The beets were not artificially inoculated with the two viruses. Under natural infection,

all plants did not acquire the diseases at one time. Plant symptoms were of varying degrees of severity, but it is assumed that beets growing in nematode-infested and nematode-free soil were affected approximately the same; and, therefore, any reduction in yield would be from effect of nematode. The results of this test are presented in table 2. Loss of root weights due to nematode attack varied from 1.0% to 28.4%. Loss in the check (US 41) was 30.4%. Sugarbeets grown in nematode-infested soil were lower in yield than the same line grown in nematode-free soil. The average reduction in sucrose content of the twelve entries in the test was .81%. A similar test is given in 1961 Report.

Additional studies on the cyst nematode, by Savitsky and Price, on page 247; and by Steele and Price, page 264.

AGRONOMIC EVALUATION TEST, 1962

Conducted: by Charles Price

Location: Salinas, California

Date of Planting: April 18, 1962

Date of Harvest: September 17, 1962

Experimental Design: Randomized Block

Size of Plot: 1 row 25 feet long

Stand Count: At harvest

Field History: Vetch cover crop during winter; sugarbeets 3 years with nematode cysts and root-rotting fungi added to the soil each year.

Fertilization: 100 pounds P_2O_5 per acre applied to cover crop, 219 pounds of nitrogen per acre as a side dressing to the beets.

Virus Yellows Exposure: Severe

Root Rot Exposure: Severe

Nematode Exposure: Severe

Other Diseases: Western yellows and mosaic

Table 1. SUGARBEET NEMATODE RESISTANCE EVALUATION TEST,

SALINAS, CALIFORNIA, 1962

Line or Variety	Acre Yield	Increase Acre Yield over Check (US 41)	Increase Acre Yield over Commercial Variety (US 75)	Beets per 100 ft. row
	Tons	Tons	Tons	Number
033-1	19.95	10.45	11.98	120
SL060-3	19.59	10.09	11.62	121
856-1	18.71	9.21	10.74	119
150-1	18.10	8.60	10.13	118
C057-15	17.63	8.13	9.66	120
SL054-1	16.52	7.02	8.55	117
896	16.34	6.84	8.37	114
060	15.64	6.14	7.67	120
159-8	15.62	6.12	7.65	118
861-15	15.54	6.04	7.57	117
162-15	15.41	5.91	7.44	116
054-1	15.36	5.86	7.39	114
861-25	15.11	5.61	7.14	119
B076	15.10	5.60	7.13	115
0317	14.95	5.45	6.98	113
802-5	14.89	5.39	6.92	112
134H8	14.85	5.35	6.88	116
057-10	14.74	5.24	6.77	114
050-6	13.85	4.35	5.88	112
894	13.75	4.25	5.78	112

Table 1 - Continued

Line or Variety	Acre Yield Tons	Increase Acre Yield over Check (US 41) Tons	Increase Acre Yield over Commercial Variety (US 75) Tons	Beets per 100 ft. row Number
875	13.42	3.92	5.45	111
801-13	12.83	3.33	4.86	113
B075	12.75	3.25	4.78	110
339	12.64	3.14	4.67	116
133-3A	12.62	3.12	4.65	115
028	12.59	3.09	4.62	114
063	12.56	3.06	4.59	113
857-5	12.52	3.02	4.55	111
835	12.24	2.74	4.27	110
171-13	12.23	2.73	4.26	111
156-22	12.22	2.72	4.25	109
062-11	12.21	2.71	4.24	110
157-F3	12.16	2.66	4.19	109
338	12.08	2.58	4.11	108
101-7	12.01	2.51	4.04	98
801-7	11.95	2.45	3.98	96
192	11.85	2.35	3.88	91
CF868	11.61	2.11	3.64	90
90-107	11.48	1.98	3.51	85
062-15	11.35	1.85	3.38	80

Table 1 - Continued

Line or Variety	Acre Yield Tons	Increase Acre Yield over Check (US 41) Tons	Increase Acre Yield over Commercial Variety (US 75) Tons	Beets per 100 ft. row Number
854-2	11.28	1.78	3.31	77
128-B-1	11.17	1.67	3.20	75
102-9	10.80	1.30	2.83	68
060-3	10.12	.62	2.15	65
862	9.96	.46	1.99	63
101	9.76	.26	1.79	64
U074	9.76	.26	1.79	61
US 41	9.50	___	1.53	60
US 75	7.97	-1.53	___	68

Table 2. TEST FOR NEMATODE RESISTANCE IN 3-GALLON CROCKS, SALINAS, CALIFORNIA, 1962

Variety or Line	Non-infested Av. Wt. Per Beet Grams	Sucrose Percent	Infested Av. Wt. Per Beet Grams	Sucrose Percent	Wt. Loss Due to Nematode Percent
019	1381.9	13.7	1367.9	13.1	1.0
062-11	1306.3	13.7	1287.0	12.1	1.5
033-1	1198.2	13.0	1127.2	12.1	5.9
1089G	1410.6	13.6	1263.9	12.7	10.4
050-6	1419.8	12.5	1248.7	12.0	12.1
U074	1348.8	14.4	1109.6	13.9	17.7
801-7	1209.9	14.7	991.8	13.4	18.0
057-15	1591.1	14.5	1269.4	13.1	20.2
1033-1	1492.2	12.5	1186.6	12.1	20.5
028	1524.0	14.7	1100.2	13.7	27.8
857-3	1572.2	15.0	1125.6	14.5	28.4
US 41	1273.0	14.0	886.5	13.9	30.4
L. S. D. 5%	224.9				
L. S. D. 1%	295.6				
Average % Sucrose		13.86		13.05	
Reduction % Sucrose Due to Nematodes					.81

PART IX

NEMATOLOGY INVESTIGATIONS

Foundation Project 13

J. M. Fife
Charles Price

Helen Savitsky
Arnold E. Steele[1]

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Progress report on studies to determine the efficacy of various legume crops in controlling Heterodera schachtii.

Arnold E. Steele and Charles Price

In studies of rotation systems on nematode infested land, Johnson and Wheatley (1959) found that inclusion of beans in the rotation greatly increased yields of sugar beets. Golden and Shafer (1959) demonstrated that beans had a stimulatory-trap crop effect on larvae of the beet nematode and suggested that beans might have some practical value in rotation systems for the control of this pest.

Field studies designed to determine the efficacy of nematode control practices are made difficult by within-plot variations in nematode populations and soil characteristics, transport of cysts and eggs by water, soil insects, and cultivation equipment, and multiplication of nematodes on weed hosts.

Jones (1955, 1956a, and 1956b) found that some of the difficulties associated with population studies using field plots were overcome when microplots were used. Microplots described by this worker were constructed of slotted concrete posts and paving stones joined together with bitumastic, and measured 2 feet 4 inches square and two feet deep. Mai (1958) reported successful use of 8 x 5 feet plots bounded by 12-inch redwood boards for research involving the golden nematode, Heterodera rostochiensis. The success of these workers suggested that similar microplots might be used to study the efficacy of various legume crops for controlling the sugar beet nematode, Heterodera schachtii.

Fifty bins, measuring 4 feet square and 3 feet deep, were constructed of 3/4" x 12" redwood, lined with polyethylene plastic sheeting, and sunk into the ground to a depth of 2 1/2 feet. Aluminum nails were used in the

construction of the bins. The bins were arranged so that 2 groups of 25 bins were separated by a 12-foot alley. Individual bins of each group were placed 4 feet apart. Examination of the soil in the experimental area did not reveal the presence of nematode cysts.

Sugar beets (Beta vulgaris L. cv. U.S. 75) were grown in individual aluminum-foil cylinders containing steam-sterilized soil. When the plants were well established, the aluminum foil was removed and 16 beets transplanted to each bin. Infested soil was added to one-half of the plots at the time the beets were transplanted.

Soil samples were obtained from each plot on March 9, 1961, after beets had been removed. The samples were oven dried, weighed, and processed to recover cysts. None of the samples from non-infested plots contained cysts. Cyst counts of samples from infested plots appear in table 1.

Leguminous crops were planted on April 27 1961 and May 25, 1962. Each of the crops were replicated 5 times in a randomized block design. Crop treatments were as follows: Kentucky wonder white-seeded pole beans (Phaseolus vulgaris L.), Small white navy beans (Phaseolus vulgaris L.), Telephone dark-poded peas (Pisum sativum), White Dutch clover (Trifolium repens), and Chilean alfalfa (Medicago sativa). Each plot receiving peas or beans contained 4 planting rows spaced 1 foot apart while seeds of clover or alfalfa were broadcast planted.

Random samples were obtained from the microplots on October 25, 1961 and October 25, 1962, after legume crops were removed from the plots. The samples were oven dried, weighed, and processed to recover cysts. Cyst counts of these samples appear in tables 2 and 3.

There were no significant differences in cyst populations between crop treatments at either sampling date. However, these data do not indicate the viability of the cyst contents. Sugar beets will be grown in the plots in 1963 to evaluate differences in viability of cyst populations.

The information obtained from this study should indicate which legumes are of practical value in controlling the sugar beet nematode.

Table 1. Numbers of cysts of Heterodera schachtii per 100 grams of soil sampled on March 9, 1961.

		Replications						
		1	2	3	4	5	Total	Average
Navy beans	I	42	46	40	63	56	247	49.4
Clover	II	38	52	64	36	57	247	49.4
Alfalfa	III	36	49	59	67	35	246	49.2
Pole beans	IV	47	62	31	50	51	241	48.2
Peas	V	42	62	37	64	39	244	48.8
Total		205	271	231	280	238	1,225	

Table 2. Sampled October 25, 1961.1/

Navy beans	I	19	23	31	27	23	123	24.6
Clover	II	26	40	62	22	28	178	35.6
Alfalfa	III	30	35	37	31	25	158	31.6
Pole beans	IV	26	23	17	29	27	122	24.4
Peas	V	30	40	18	17	25	130	26.0
Total		131	161	165	126	128	711	

Table 3. Sampled October 25, 1962 1/

Navy beans	I	23	37	28	36	28	152	30.4
Clover	II	20	21	23	23	31	118	23.6
Alfalfa	III	25	36	27	33	29	150	30.0
Pole beans	IV	26	30	23	36	34	149	29.8
Peas	V	34	30	17	23	25	129	25.8
Total		128	154	118	151	147	698	

1/ Number of cysts/100 grams soil.

The effects of concentration of sugar beet root diffusate by drying, boiling, or freezing on diffusate hatching activity.

Arnold E. Steele and J. Milton Fife

The search for more effective means of controlling plant parasitic nematodes has included attempts to develop materials that stimulate hatching of larvae. A number of workers (Calam, et. al. 1949, Carrol, 1958, Ellenby, 1958, Fassuliotus and Feldmesser, 1952, Massey,and Neal, 1953, Widdowson and Wiltshire, 1958) have investigated the chemical composition of root exudates of certain plants that accelerate the rate of hatching of nematode larvae.

Methods of concentration, extraction, or fractionation, of plant root diffusates for bioassay are limited to those which do not influence the stimulatory properties of diffusate. Tests reported herein were designed to determine if sugar beet root diffusate can be concentrated by drying, boiling or freezing without loosing its ability to accelerate hatching of beet nematode larvae.

Materials and Methods

Beet root diffusate was leached from four-inch pots, each of which contained 3 sugar beet seedlings (Beta vulgaris L. cv. U.S. 75). Two hundred ml of diffusate was collected from each pot in a 24-hour period. Fresh diffusate obtained at weekly intervals was divided into several 50 ml portions.

Fifty ml of diffusate was evaporated to dryness by continuously directing a jet of forced air down upon the surface. The dried residue was redissolved in 1000 ml of tap water to bring the concentration of the

A 100 ml volumetric flask containing 50 ml of diffusate was sealed with a cork stopper and placed in an inverted position in the freezing compartment of a refrigerator until only 8 to 11 ml remained unfrozen. The unfrozen portion was separated from the ice and the solution was brought to 5% of its original concentration by addition of tap water.

Other treatments of this test included 5% solutions of diffusate, undiluted diffusate, and tap water.

Two tests were designed to compare the effects of refluxed beet root diffusate, untreated diffusate and tap water on emergence of larvae from cysts of the beet nematode. One hundred fifty ml aliquots of diffusate, in flasks fitted with reflux condensers, were held at boiling for 1, 2, 4, 8, 16, 32, and 64 minutes. One test included an additional treatment of beet diffusate refluxed for 128 minutes. Immediately after termination of the heat treatments, the diffusates were brought to room temperature by placing the flasks in an iced water bath. All diffusate samples were filtered before use.

The conduct of the hatching tests of each study was essentially the same. Each treatment was replicated 4 times in separate watch glasses containing 40 beet nematode cysts and approximately 15 ml of treatment solution. The watch glasses, with contents, were kept in a dark,aerated cabinet in the laboratory during the 6-week test period. At weekly intervals the cysts were transferred to clean watch glasses containing fresh solutions and the emerged larvae preserved in 5% formalin until counted. Samples that contained large numbers of larvae were aliquoted for counting. Data for all tests were analyzed for statistical significance by the analysis of variance method.

Results and Conclusion

Data listed in Table 1 demonstrate that beet root diffusate can be concentrated by drying or freezing with no measurable loss in hatching activity. An unreported test at this laboratory revealed that no loss of hatching activity resulted when diffusate was stored in a frozen condition for 11 months.

Results of 2 tests (Tables 2 and 3) revealed that boiling beet diffusate for 32 minutes or longer significantly reduced the diffusate hatching activity. Although the activities of diffusate boiled from 1 to 16 minutes were not significantly different from that of untreated diffusate, diffusate activity decreased as the time of treatment was increased.

Further studies may determine if exposure of diffusate to temperatures in excess of 100° C. results in complete inactivation of the hatching factor.

The pH of beet root diffusate obtained under the conditions described herein varied from 6.0 to 6.5, whereas the total solids amounted to less than 0.5% as determined with the aid of a refractometer. Within these ranges, pH does not significantly affect hatching of beet nematode larvae (see influence of pH on larval hatch elsewhere in this report).

Table 1. The effects of concentration of sugar beet root diffusate by boiling or drying on diffusate hatching activity.[1/]

Treatment solution	Method of concen-tration	% concen-tration	Replications 1	2	3	4	Total	Average
Tap water	--	--	1,800	2,180	1,980	1,900	7,860	1,965
Beet diff.	Frozen	5	7,670	7,130	5,750	5,720	26,270	6,568
" "	Dried	5	5,820	7,460	8,570	6,560	28,410	7,103
" "	--	5	6,470	8,900	8,460	5,850	29,680	7,420
" "	--	100	10,140	6,820	8,940	8,300	34,200	8,550
Significance								**
LSD .05								1,801

Table 2. The effects of heating sugar beet root diffusate on diffusate hatching activity.[1/]

Treatment	Boiling time	Replications 1	2	3	4	Total	Average	% beet hatch
Tap water	0	330	620	1,180	780	2,910	728	10.2
Beet diff.	1	4,800	4,740	7,340	5,730	22,610	5,653	79.0
" "	2	5,260	8,110	6,990	6,760	27,120	6,780	94.8
" "	4	7,160	6,250	7,480	6,960	27,850	6,963	97.3
" "	8	4,970	7,050	8,480	7,380	27,880	6,970	97.4
" "	16	3,780	5,330	8,220	7,390	24,720	6,180	86.4
" "	32	2,770	6,620	5,290	5,140	19,820	4,955	69.3
" "	64	3,530	6,380	4,970	4,340	19,220	4,805	67.2
" "	0	4,440	6,340	9,620	8,210	28,610	7,153	100.0
Significance							**	
LSD .05							1,510	21.1

1/ Figures indicate the total numbers of larvae emerged from 40 cysts exposed 6 weeks to various treatments.

Table 3. The effects of heating sugar beet root diffusate on diffusate hatching activity.[1/]

Treatment	Boiling time	Replications 1	2	3	4	Total	Average	% beet hatch
Tap water	0	760	1,040	880	810	3,490	873	14.7
Beet diff.	1	5,120	4,940	5,450	6,140	21,650	5,413	91.4
" "	2	7,620	7,490	5,400	5,980	26,490	6,623	111.8
" "	4	5,300	5,480	7,170	5,770	23,720	5,930	100.1
" "	8	4,800	6,190	5,570	5,390	21,950	5,488	92.6
" "	16	4,320	5,160	6,200	5,600	21,280	5,320	89.8
" "	32	4,280	3,500	5,900	2,740	16,420	4,105	69.3
" "	64	3,920	3,350	4,200	2,550	14,020	3,505	59.2
" "	128	3,800	3,550	2,830	3,180	13,360	3,340	56.4
" "	0	6,070	5,330	6,350	5,950	23,700	5,925	100.0
Significance							**	
LSD .05							1,114	18.8

1/ Figures indicate the total number of larvae emerged from 40 cysts exposed 6 weeks to the various treatments.

The influence of pH on emergence of larvae from cysts of *Heterodera schachtii*.

Arnold E. Steele and J. Milton Fife

The 1961 annual report of this station included a report of a test that was undertaken to determine the influence of pH on emergence of larvae from cysts of the sugar beet nematode. Data of this test indicated that phosphate buffer solutions of pH 5, 6, 7, 8, and 9 significantly increased the emergence of larvae from cysts. Larval hatch in buffer solutions of pH 5 amounted to 46% of hatch in beet root diffusate.

The test reported below was initiated to further study the influence of phosphate buffer solutions on hatching and emergence of larvae from cysts of *Heterodera schachtii*.

Materials and Methods

Treatments consisted of buffer solutions of pH 3.4, 4.5, 6 or 7, containing either potassium or sodium ions, beet root diffusate, or tap water. Stock .0666 molar solutions were prepared by dissolving 9.078 grams potassium dihydrogen phosphate, 14.0 grams dipotassium hydrogen phosphate, 8 grams sodium dihydrogen phosphate, or 11.876 grams disodium hydrogen phosphate in 1 liter of distilled water. Buffer solutions were prepared by mixing the stock solutions in proportions recommended by Clark (1928) for Sorensen's phosphate mixtures,so that the solutions contained either sodium or potassium but not both. After the buffer solutions were diluted to one-tenth of the original concentrations to obtain .0066 molar solutions, the solutions were adjusted to the desired pH by addition of 0.5N HCl. Treatments were replicated 4 times in Syracuse watch glasses which contained 40 nematode cysts and 15 ml of treatment solution. Conduct of the test was essentially the same as reported for other hatching tests.

Results and Conclusions

The numbers of larvae emerged in phosphate buffer solutions of pH 3.4 containing either sodium or potassium were similar to the numbers of larvae emerged in tap water. All other buffer solutions gave hatches significantly higher than tap water and significantly lower than sugar beet root diffusate. No increasing or decreasing trends were evident from hatches occurring in buffer solutions of pH 7 to pH 4. Data of this test indicate that hatching will occur within a wide range of hydrogen ion concentrations.

Total numbers of <u>Heterodera schachtii</u> larvae emerged from cysts exposed 6 weeks to various buffer solutions, beet-root diffusate, or tap water.

Treatment		Replications				Total	Average
Component	pH	1	2	3	4		
Tap water	-	1,041	1,094	867	1,608	4,610	1,152.5
Potassium Buffer	3.4	1,606	916	1,967	1,698	6,187	1,546.7
" "	4.0	3,548	2,774	2,968	3,086	12,376	3,094.0
" "	5.0	4,226	3,273	2,858	3,463	13,820	3,455.0
" "	6.0	2,226	2,567	2,624	1,705	9,122	2,280.5
" "	7.0	2,843	3,139	3,612	2,917	12,511	3,127.8
Sodium Buffer	3.4	1,409	2,153	870	1,226	5,658	1,414.5
" "	4.0	2,996	2,458	2,624	2,234	10,312	2,578.0
" "	5.0	2,918	2,084	2,694	2,247	9,943	2,485.8
" "	6.0	2,612	2,819	2,399	3,330	11,160	2,790.0
" "	7.0	2,213	1,885	2,986	2,291	9,375	2,343.8
Beet diffusate		7,947	6,578	8,174	10,115	32,814	8,203.5
Total		35,585	31,740	34,643	35,920	137,888	
Significance							**
LSD .05							845.8

The effects of amino acids or sugar beet phloem exudate on the emergence of larvae from cysts of *Heterodera schachtii*.

Arnold E. Steele and J. Milton Fife

Certain investigations conducted at this laboratory are concerned with attempts to discover materials which will effectively stimulate the hatching and emergence of larvae from cysts of the sugar beet nematode. Materials of this nature, if effective in the field, may increase the efficacy of control of the sugar beet nematode by crop rotation and/or soil fumigation.

The presence of a material in sugar beet root diffusate which accelerates the hatching of larvae suggests the hatching factor may be an organic compound. The tests reported below were concerned with attempts to determine the effects of certain amino acids reported to occur in sugar beets or of sugar beet phloem exudate on emergence of larvae from cysts of the sugar beet nematode.

Materials and Methods

Treatments of two separate tests included valine, *dl* alpha amino-n-butyric acid, phenylalanine, serine, asparagine, arginine, gamma amino butyric acid, aspartic acid, *dl* methionine, *dl* citrulline, glycine (amino acetic acid), *l* leucine, sugar beet root diffusate, or tap water. Aqueous solutions of amino acids, prepared in concentrations of 1000 ppm were stored in a refrigerator until needed.

Treatments of a third test included 1 or 10 percent sugar beet phloem exudate, 1 percent, 10 percent, or undiluted sugar beet root diffusate, or tap water. Phloem exudate, collected from the root of sugar beet by Fife, et. al., (1962) had been stored at 10° F. for more than five years.

Each treatment was replicated 4 times in separate Syracuse watch glasses containing 40 cysts. Except as already noted, the methods used in these studies were those described in other hatching tests of this report.

Results and Conclusions

The numbers of larvae emerged in amino acid solutions were considerably lower than that in tap water. The apparent inhibitory effects of these chemicals may be due to excessive growth of fungi which appeared early in these cultures.

No acceleration of larval emergence occurred when cysts were treated with 1 or 10 percent phloem exudate.

Effects of amino acids on emergence of larvae from cysts of Heterodera schachtii.

TEST I[1/]

Treatments	Replications 1	2	3	4	Total	Average
1. Tap water	1,216	2,304	2,284	2,584	8,388	2,097.0
2. Valine	202	251	226	773	1,452	363.0
3. Butyric acid[2/]	93	320	175	822	1,410	352.5
4. Phenylalanine	228	171	36	37	472	118.0
5. Serine	118	60	85	117	380	95.0
6. Asparagine	138	22	8	43	211	52.8
7. Arginine	16	4	5	95	120	30.0
8. Beet diffusate	7,848	7,489	6,157	7,008	28,502	7,125.5
Total	9,859	10,621	8,976	11,479	40,935	

1/ Total numbers of larvae emerged from 40 cysts in 6 weeks.

2/ D.L. Alpha amino-n-Butyric acid.

Effects of amino acids on emergence of larvae from cysts of <u>Heterodera</u> <u>schachtii</u>.

TEST II[1/]

Treatments	Replications 1	2	3	4	Total	Average
1. Tap water	2,467	2,233	1,795	2,244	8,739	2,184.7
2. Butyric acid[2/]	1,278	1,189	592	662	3,721	930.3
3. Aspartic acid	723	275	796	320	2,114	528.5
4. Methionine	359	249	227	332	1,167	291.8
5. Citrulline	200	224	83	158	665	166.3
6. Glycine	132	43	24	69	268	67.0
7. Leucine	28	14	28	14	84	21.0
8. Beet Diffusate	4,845	5,669	5,493	6,374	22,381	5,520.3
Total	10,032	9,896	9,038	10,173	39,139	

The effects of sugar beet phloem exudate on emergence of larval of <u>Heterodera</u> <u>schachtii</u>.

TEST III[3/]

	Percent concentration	Replications 1	2	3	4	Total	Average
Tap water	-	154	231	101	130	616	154.0
Phloem exudate	1	14	27	37	609	687	171.8
" "	10	2	2	26	7	37	9.3
Beet diffusate	1	445	394	979	766	2,584	646.0
" "	10	891	937	1,070	1,033	3,931	982.8
" "	100	5,349	4,736	2,747	4,830	17,662	4,415.5
Total		6,855	6,327	4,960	7,375	25,517	

1/ Total numbers of larvae emerged from 40 cysts in 4 weeks.
2/ Gamma amino Butyric acid.
3/ Total numbers of larvae emerged from 40 cysts in 3 weeks.

Susceptibility of several *Beta* species to the sugar beet nematode (*Heterodera schachtii* Schmidt).

Arnold E. Steele and Helen Savitsky

Species of the genus *Beta* resistant to the sugar beet nematode (*Heterodera schachtii* Schm.) are of interest because of their possible use in breeding nematode-resistant varieties of sugar beets. Hijner (1951), Winslow (1954), Golden (1958 and 1959), Shepherd (1957 and 1959), and Viglierchio (1960) tested *B. patellaris*. Shepherd (1957) and Golden (1958) found males only on its roots. Shepherd (1959) found four females on plants exposed to three out of eight populations examined for resistance-breaking biotypes of the beet nematode.

Twenty-five seed of each of seven species of *Beta*[1/] were planted in individual aluminum-foil cylinders of soil infested with *H. schachtii*. After 50 days growth in a greenhouse, the roots of each plant were examined for adult female beet nematodes. A few were removed from several plants of each species to determine whether developing eggs or larvae were present. Results are listed in table 1.

Single adult females were found on the roots of two plants of *B. patellaris*; one female contained eggs in early stages of development; the other female contained eggs which did not appear to be undergoing development, suggesting that the eggs probably had not been fertilized. Beet seedlings in clay pots of sterilized soil were inoculated with the eggs from the females found on *B. patellaris*. Sixty days later one adult female and four brown cysts were extracted from one pot. No adults were recovered from roots or soil of the plant inoculated with eggs which appeared not to have been fertilized.

1/ Seed of wild *Beta* species were obtained from V. F. Savitsky, Salinas, California.

This confirms Shepherd's results and adds *B. intermedia*, *B. corolliflora*, and *B. macrorrhiza* to the list of species highly susceptible to the sugar beet nematode.

Table 1. Susceptibility of *Beta* species to the sugar beet nematode.

Species	No. plants infected	Infection index*	Embryonated eggs & larvae present
B. corolliflora Zoss.	25	++	yes
B. intermedia Bunge	25	++	yes
B. lomatogona Fisch & Meyers	25	++	yes
B. macrorrhiza Stev.	25	++	yes
B. patellaris Moq.	25	+	yes
B. trigyna Wald & Kitt	25	++	yes
B. vulgaris L. Var. U.S. 75	25	++	yes

*Infection index: ++ = heavily infected; + = lightly infected.

P A R T X

MOSAIC INVESTIGATIONS

- - -

CURLY TOP INVESTIGATIONS

- - -

VIRUS YELLOWS INVESTIGATIONS[1]

- - -

BREEDING FOR YELLOWS RESISTANCE

Foundation Project 12

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J. M. Fife
J. S. McFarlane
I. O. Skoyen

[1] Investigations supported in part by funds received from California Beet Growers Association, Limited, under Cooperative Agreement.

YELLOWING OF LEAVES OF YOUNG SUGARBEET PLANTS IN WESTERN UNITED STATES

C. W. Bennett

Over the past 4 years, leaves of small sugarbeet plants in various parts of California have shown a type of yellowing early in the season that has alarmed some of the growers whose fields were affected. In several instances the yellowing was mistaken for early infection with yellows viruses, and some growers seriously considered plowing up their plantings.

Yellowing is of a characteristic type and becomes evident soon after thinning. It usually occurs on the first 2 to 8 leaves. Often, the affected plants have a distinctly yellow cast. If high percentages of plants are affected, fields present a noticeably yellow appearance.

This type of yellowing is now known to occur over a wide geographical range and under a variety of soil and climatic conditions. In March, 1959, more than 50 percent of the plants in some fields in Kern County, California, were affected. Yellow plants have been found in a number of fields in the Salinas, San Joaquin, and Sacramento Valleys during the past 3 years, but percentages of plants affected have been low in most cases. In March, 1961, a plant showing this type of yellowing was found in a sand culture, watered with Hoagland solution, in a greenhouse at Salinas, California.

In May, 1962, B. J. Landis of the U. S. Department of Agriculture sent plants to Salinas from Walla Walla, Washington, which showed marked yellowing of leaves. Other plants were received in early June, 1962, from Nyssa, Oregon. George E. Rush of the Amalgamated Sugar Company,

who collected the plants, reported that yellowing was widespread in the Nyssa area.

In affected fields, yellowing may begin to appear on the first pair of true leaves when they are less than half grown and it may continue to appear on the next 2 to 6 leaves. First evidence of abnormality is a light-yellow blotching that becomes more conspicuous as the spots take on a light-golden hue. The yellow areas are of various sizes and shapes and the margins are not sharply delimited. The yellow splotches may appear on any part of the leaf and may range from a single spot to many spots that coalesce to produce a yellow leaf. The splotches, however, more often occur between the main lateral veins, as shown in Figure 1. The affected leaves do not recover, but symptoms become less evident on the successive leaves as the plant grows. Recovery is complete in the later growth.

Unsuccessful attempts were made to transmit a virus from a number of affected plants by juice inoculation and by means of the green peach aphid, Myzus persicae (Sulz.). No evidence was obtained that the disturbance is caused by an infectious agent. Although the yellowing has been confused with virus yellows, symptoms are distinctly different. Under California conditions, yellows viruses rarely produce symptoms in the field on the first pair of leaves of beet plants. If symptoms do appear on such leaves they are likely to be restricted to one or more segments of the leaf and neither of the yellows viruses produces splotching of the type described above.

The cause of this type of yellowing of leaves of young beet plants is not known, but yellowing seems to be associated with accumulation of salts or other substances in irrigated soils. Some of the fields

affected in Kern County in 1959 were planted on 2-row beds. Plants on the higher portions of the beds showed more yellowing than those on lower portions. Plants that had taken root in the furrows between beds after thinning were almost wholly free of yellowing. Salts, and possibly other materials, had become more concentrated in the higher portions of the rows through evaporation of water that had subbed up from the irrigation furrows. Salt deposits were evident on the soil surface in such areas. Yellowing was not correlated with any type of fertilizer practice used in the affected fields.

Yellowing has been associated, however, with relatively low temperatures during the early stages of plant development, and it seems probable that whatever the primary cause of the disturbance may be, its effects are accentuated by low temperatures.

In all cases where this type of yellow spotting has been observed, affected plants recovered after the production of the first 2 to 8 leaves. Fields that were extensively affected in Kern County in 1959 produced good yields, and there was no evidence that the early leaf yellowing had appreciable effect on root yield or sugar content at harvest.

Figure 1. Sugarbeet leaves showing yellow splotches commonly found on young plants in California and other western States. The light-colcred areas are light golden yellow under field conditions.

ISOLATES OF BEET MOSAIC VIRUS WITH DIFFERENT DEGREES OF VIRULENCE

C. W. Bennett

Introduction

Beet mosaic has been reported from all countries where sugarbeets are grown commercially. It is the most common and widespread of all of the virus diseases of this crop. It occurs in all of the commercial beet areas of California and many fields have high percentages of infection at harvest. Symptoms usually are mild and tend to be masked during the warmer part of the season. In general, the disease has not been considered a highly important factor in beet production. In recent years, however, more evidence has accumulated, indicating that beet mosaic is capable of causing measurable reduction in yield, under some conditions, in both the seed and the root crop.

It is possible that a part of this apparent increase in importance of mosaic as a disease of sugarbeet is due to increased prevalence of more virulent strains of the causal virus.

Observations and studies have been made during the past few years to determine whether more highly virulent strains of the virus may be involved in losses caused by this disease. Beets in the seed-producing area near Tehachapi, California, have shown mottling and leaf distortion that are uniformly more severe than in other areas. In 1959 and 1960, plants showing marked symptoms of mosaic were selected at Tehachapi and tested on potted plants in the greenhouse. Symptoms produced by virus from some of these selections proved to be more severe than those produced by isolates from beets from the Salinas Valley.

Beet plants have also been found in other parts of California which showed symptoms more severe than average. One of these plants, which showed unusually severe symptoms, was selected from a field near Stockton, California, in 1961 for more extensive study. The virus was transferred from this plant to greenhouse plants for further comparison with a stock virus culture from the Salinas Valley. The results of these comparisons are presented in this report. The Salinas Valley isolate is designated "common mosaic virus isolate" (C), and the isolate from Stockton is designated "severe mosaic virus isolate" (S).

Description of Symptoms

Common Mosaic. Under field conditions, symptoms are evident on sugarbeet plants throughout the year. They tend to be more marked, however, in the spring and fall or during periods of rapid growth. Typical symptoms consist of different patterns of mottling varying from small, more or less circular chlorotic spots to larger chlorotic areas that collectively cover most of the leaf surface. There is little leaf distortion and the disease does not noticeably dwarf the plant under field conditions (Figure 1B).

Under greenhouse conditions, first symptoms of disease appear on the young leaves and may consist of translucency of veins similar to that produced by curly top virus, except that the translucent areas produced by mosaic are broader. Soon the young leaves show chlorotic areas of various sizes, shapes, and degrees of yellowing. Frequently no vein translucency is evident and chlorotic spots on the young leaves are the first evidence of disease.

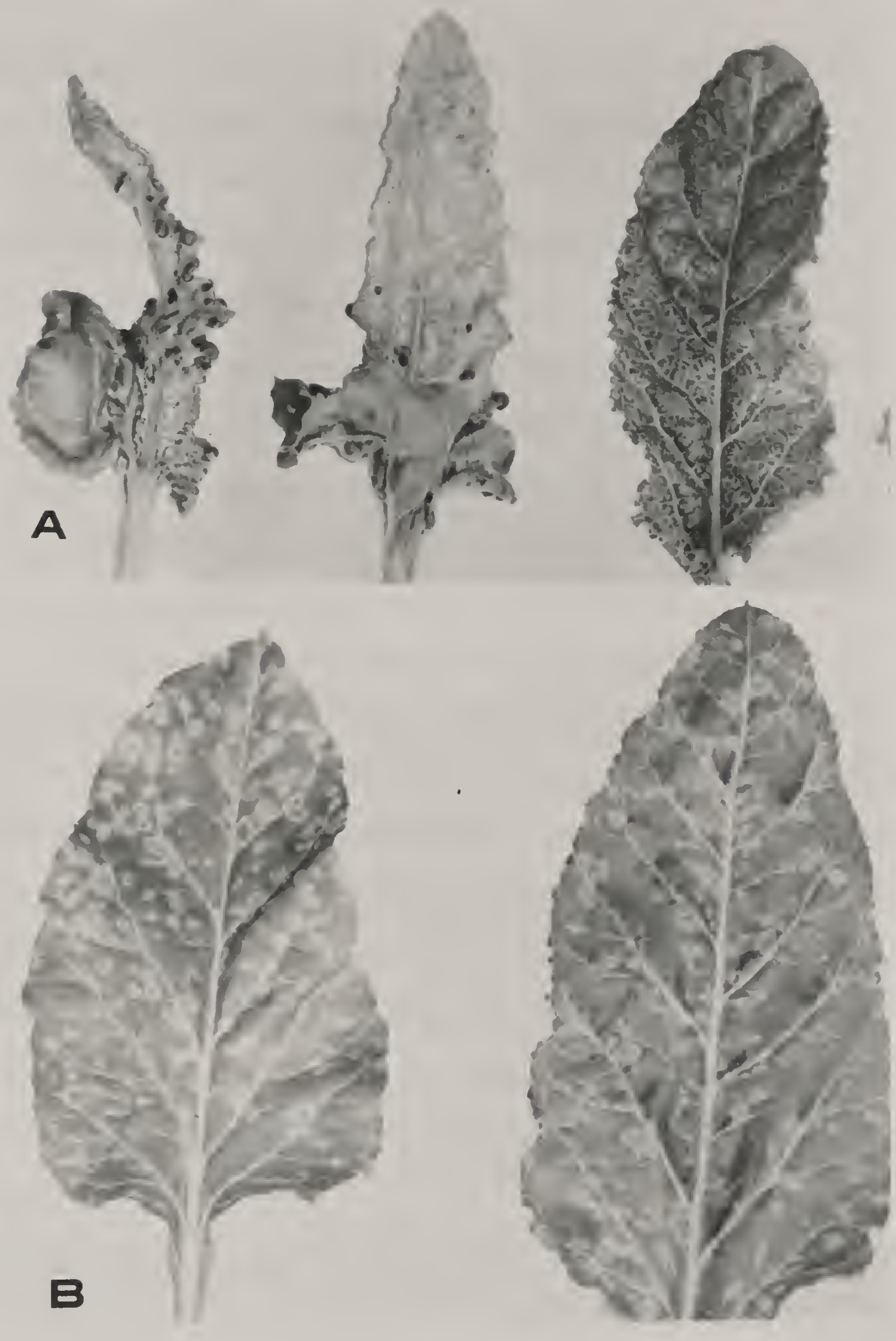

Figure 1.--(A) Sugarbeet leaves showing symptoms produced by a highly virulent isolate of beet mosaic virus. (B) Sugarbeet leaves showing symptoms produced by a less virulent strain of the beet mosaic virus.

Severe Mosaic. As with common mosaic, the first symptom of disease may consist of vein translucency or chlorosis. In some plants, veins may show necrosis. Mottling of young leaves, sometimes in the absence of vein chlorosis, soon appears. Leaves may be deformed and show green blisters (Figure 1A). As infected plants continue to grow, leaves show various stages and degrees of deformity and mottling, or they may show mottling without deformity. Mottling is more intense than in plants with common mosaic. Some plants show degrees of leaf deformity and chlorosis comparable to those produced on beets by cucumber mosaic virus.

Comparison of Two Mosaic Virus Isolates

Transmission. Both isolates are readily juice transmissible, but a higher percentage of infection has been obtained with isolate S than with isolate C. Both isolates produce local lesions on sugarbeet and on *Chenopodium amaranticolor*. Tests with sugarbeet, in which half of the leaf was inoculated with isolate C and the other half was inoculated with isolate S, gave an average of 16 local lesions per half-leaf with isolate C and 31 local lesions with isolate S in 30 single-leaf tests. Similar tests with *C. amaranticolor* gave averages of 22 and 41 for the C and S isolates, respectively.

Incubation Period in the Plant. Several tests were made in which beet plants of the same size and age were inoculated by rubbing one leaf with juice from plants infected with isolates C or S. The results of one such test in which the plants were inoculated at 3 different ages are shown in Table 1. The average time for appearance of symptoms on the inoculated plants was longer in plants inoculated with isolate C than with isolate S in each age class. This may reflect more rapid

multiplication of the S-isolate or it may indicate a greater plant sensitivity to this isolate.

Table 1. Incubation periods of severe and common mosaic virus isolates in beet plants inoculated in different stages of growth.

Stage of growth of beet plants at time of inoculation	No. of plants infected of 40 inoculated with indicated isolate[1]		Average incubation period (days)	
	S	C	S	C
2-leaf	38	22	7.3	9.3
6-leaf	39	29	13.6	16.3
12-leaf	40	36	13.3	17.1

[1] S indicates severe mosaic virus isolate; C indicates common mosaic virus isolate.

Effect of Isolates C and S on Growth of Sugarbeet in the Greenhouse. Seven greenhouse tests were made in which plants of the variety US 75 were placed in 6-inch pots and inoculated in about the 4-leaf stage with the respective virus isolates. The plants were held for 49 to 82 days after inoculation and then harvested and weighed.

The S isolate produced more severe symptoms in all tests. Plants were somewhat more yellow than those inoculated with the C isolate. Many plants had deformed leaves and the plants were more obviously stunted than those inoculated with the C isolate. Reduction in weight varied considerably in the different tests but the S isolate caused more injury than the C isolate in all tests. Each isolate caused appreciable reduction in yield (Table 2).

Table 2. Effects of two isolates of the sugarbeet mosaic virus on growth of sugarbeets under greenhouse conditions.

Test No.	Time from inoculation to harvest (days)	No. of plants with each treatment[1]	Average weight at harvest of plants inoculated with indicated virus isolate[2] (grams)		
			S	C	Check
1	62	20	17.4	18.6	26.6
2	73	20	24.1	26.4	37.2
3	62	20	62.4	68.5	79.2
4	70	20	65.3	68.4	81.5
5	49	20	137.2	149.2	164.7
6	64	20	76.0	90.5	103.3
7	82	48	259.9	269.8	277.0

[1] All plants were in 6-inch pots; 1 plant per pot in test 7, 2 plants per pot in test 5, and 4 plants per pot in all other tests.

[2] S indicates the severe mosaic virus isolate and C,the common mosaic virus isolate.

The percentage reduction in weight of plants in these tests is undoubtedly higher than that expected under field conditions. However, there is some evidence that very early infection with mosaic virus in the field may lead to appreciable reduction in weight of roots at harvest. Infection of field plants after they have attained considerable size probably causes much less damage. Rate of growth of plants may also influence the percentage reduction in yield. This may account for the smaller amount of damage to inoculated plant in Test 7 in which there was only 1 plant per pot, which provided space

for good growth from time of inoculation to harvest.

Properties of Virus Isolates. The two isolates, C and S, produce such markedly different symptoms under some conditions that it seemed desirable to make property tests to obtain further information as to whether they actually are strains of the same virus or distinct and unrelated viruses.

Thermal inactivation tests were made by placing juice from beet plants infected with the respective isolates in small thin-walled test tubes and immersing these in a water bath held at the desired temperature for a period of 10 minutes. The juice was then used to inoculate beet plants in the 4- to 6-leaf stage. There was a reduction in number of plants infected by juice held 10 minutes at 56 and 58°C., and no infection was obtained from juice held at 60° C. There was no significant difference between the two isolates.

In tests in which beet juice from infected plants was diluted with water to various degrees, a slight amount of infection was obtained with each isolate at a dilution of 1-4,000, but no infection was obtained from dilutions of 1-10,000.

Tests in which juice from diseased plants was placed in flasks and held at room temperature (21-23°C.), and used for inoculating beet plants at daily intervals, indicated a gradual decline in infectivity over a period of 6 days with loss of infectivity after 7 days. Higher percentages of infection were obtained, however, with the S isolate than with the C isolate over the 6-day period of activity.

The results of property studies indicate that the two isolates are similar in the properties tested, and on the basis of these tests it would appear that the two isolates are strains of the beet mosaic virus.

Summary and Conclusions

Results of studies of beet mosaic virus over the past 2 years at the U. S. Agricultural Research Station at Salinas, California, indicate that this virus probably occurs under natural conditions in the form of a number of variants or strains that differ in virulence on sugarbeet. Highly virulent strains of this virus may be capable of causing measurable reductions in yield of sugarbeets, particularly if infection occurs in the early stages of growth of the beet plant.

REPORT OF PROGRESS IN DEVELOPING A CHEMICAL TEST FOR IDENTIFYING SUGARBEET PLANTS RESISTANT TO VIRUS YELLOWS AS INDICATED BY A FIELD TEST

by

J. M. Fife

INTRODUCTION

The goal of these investigations is to determine if a chemical method can be developed which will identify individual plants having resistance to virus yellows and western yellows. It has been shown that the amino acid pattern is greatly upset in the mature leaves of sugarbeets showing the chronic symptoms of yellows[1/] and of western yellows[2/]. It was also found that the degree of upset in the amino acid pattern varied over a wide range among individual plants. The premise, that a chemical method of identifying individual plants having resistance to yellows is possible, is based on the observed variation in the amino acid pattern among infected plants.

Individual beet plants were selected on the basis of a superior root weight and on the magnitude of the amino acid ratio,

$$\frac{\text{aspartic acid} + \text{glutamic acid}}{\text{citrulline} + \text{alanine}},$$

in the mature leaves of yellows-inoculated plants of variety US 75.

1/ Amer. Soc. Sugar Beet Tech. XI (4) 327-333.

2/ Amer. Soc. Sugar Beet Tech. XI (7) 629-631, 1961.

A more complete description of the methods used in selecting the individual plants has been reported[3/]. The ultimate test, to determine if the chemical method will identify plants having resistance to yellows, is to produce seed and then compare the progeny with the parent in field trials under severe yellows conditions. The selected plants were, therefore, grouped for an open-pollinated seed increase. The progeny from these plants was tested with the parental variety in a test conducted in 1962. The results of this test are reported here.

METHODS AND RESULTS

The test was carried out in a section of the experimental plot along with the regular planting of the variety test for yellows resistance conducted by McFarlane, Bennett, and Skoyen. The agronomic operations were the same for the entire plot, the only difference being the experimental design. The information pertinent to this test is given below.

3/ Foundation Project. Sugar Beet Research, 1961 Report, p. 295-318.

Location: Spence field, on a Chualar sandy loam.

Fertilizer: 600 lbs. per acre of 10-10-5, preplant.
190 lbs. ammonium sulfate per acre, applied 7-3.

Planted: April 9.

Thinning: Plants thinned to approximately 8-inch spacing.

Disease: Plants inoculated in the 4-leaf stage with a virulent strain of the yellows virus.

Irrigation: At 7- to 10-day intervals with sprinklers during the first part of the growing season and furrow-irrigated the remainder of the season.

Insect control: Plots sprayed to control aphids and leaf miners.

Experimental design: 6 X 6 latin square, two-row plots 50 feet long, rows 28 inches apart.

Harvested: October 4, 170 days after emergence.

Sugar analysis: Two 10-beet samples taken from each replication.

Aphid populations were high during the spring. At the time of inoculation, May 31, most of the plants were showing symptoms of yellows brought in by aphis from nearby fields. Spraying to control the aphid populations was, therefore, discontinued.

The results of this field test is summarized in table 1. Four of the five selections produced more sugar per acre than the parent. Two selections were superior to the parent, using Duncan's multiple range test. Four selections produced a greater tonnage of beets than the parent, with one selection being superior to the parent, using Duncan's multiple range test. The roots of one selection had a significantly greater percentage sucrose than the roots of the parent. This value was significant at the 5-percent level, according to Duncan's multiple range test.

Table 1.

Field test of selections inoculated with a virulent strain of yellows virus in the early stages of growth.

Selection	Basis upon which selections made from yellows-infected plants	Acre Yield Sugar	Acre Yield Beets	Sucrose	Hvst. Count
	A Superior	Pounds	Tons	Percent	No.
US 75 (Parent)		2953	10.7	14.3	138
91DS-7	Root Wt. & greater than mean A.A. ratio 1/	2675	9.7	13.7	141
91DS-3	Same as above	3439a	11.4	15.1a	138
91DS-C	Same as above	3347	11.6	14.5	139
101RS-C	Root Wt. & also a superior A.A. ratio 1/	3627a	12.3a	14.8	136
101RS-202S	Same as above	3339	11.4	14.7	133

1/ Amino acid ratio: $\frac{\text{Aspartic acid + Glutamic acid}}{\text{Citrulline + Alanine}}$

Beets 100' row

"a" Superscript: Superior to the parent, using Duncan's multiple range test.

	Sugar	Beets	Sucrose
General mean of all selections	3299	11.2	14.5
S. E. of MEAN	126	0.47	0.25
Significant Difference (19:1)	366	1.37	0.72
S. E. of MEAN in % of MEAN	3.8	4.2	1.7

Odds 19:1 = $2.060 \times \sqrt{2} \times$ Standard Error of MEAN

VARIANCE TABLE

Variation	Degrees Freedom	MEAN SQUARES Sugar Pounds	Tons Beets	Percent Sucrose
Between selections	5	733,445	4.88	1.45
Between replications	5	570,094	4.98	0.13
Remainder (Error)	25	94,660	1.33	0.35
Total	35			
Calculated F Values		7.75**	3.68*	4.11**

* Exceeds the 5% level (F=2.60)
** Exceeds the 1% level (F=3.86)

Table 2.

Yield of sugar and beets per acre and percentage sucrose in roots relative to parent in field tests of selections made on the basis of root size and on the magnitude of the amino acid ratio in the mature leaves of yellows-infected plants.

Selection	Year of Test	Basis upon which selection was made	Relative Acre Yield Sugar	Relative Acre Yield Beets	Relative Percent Sucrose
		A Superior			
US 75 (Parent)			100	100	100
91DS-9	1961	Root Wt. & greater than mean A.A. ratio [1/]	133[a]	133[a]	98
91DS-22	1961	Same as above	135[a]	131[a]	94
91DS-23	1961	Same as above	130[a]	119	107[a]
91DS-24	1961	Same as above	119	112	103
91DS-7	1962	Same as above	90	91	96
91DS-3	1962	Same as above	116[a]	106	106[a]
91DS-C	1962	Same as above	113*	108*	101
101RS-5	1961	Root Wt. & also a superior A.A. Ratio	86	85	107[a]
101RS-C	1962	Same as above	122[a]	115[a]	104
101RS-202S	1962	Same as above	112*	106*	103

1/ Amino acid ratio: $\frac{\text{Aspartic acid + Glutamic acid}}{\text{Citrulline + Alanine}}$

"a" Superscript: Superior to the parent when applying Duncan's multiple range test.

* Superior to the parent when applying the LSD test.

The selections tested in 1961 and those tested in 1962 are compared in table 2. The yield of sugar and beets per acre and the percentage sucrose in the roots are calculated relative to the parent, which in each case was taken as 100.

Despite the generally unfavorable conditions for maximum yield of sugarbeets in the Salinas valley for the year 1962, the performance of the selections tested this year compare favorably with the selections tested in 1961. In general, in both years some of the selections appear to be superior to the parent.

SUMMARY

The increased yield in sugar per acre of selections 91DS-9, 91DS-22 and 101RS-C, was due to an increase in tonnage of beets over that of the parent. The increased yield in sugar per acre of two other selections; namely, 91DS-23 and 91DS-3, was due to a significantly greater sucrose percentage in the roots.

Although further field tests are necessary to demonstrate that certain selections are superior to the parent under severe yellows conditions, the results of these tests indicate that progress in breeding for resistance to yellows may be made by selection on the basis of root size and on the magnitude of the amino acid ratio in the mature leaves of yellows-infected beet plants.

BREEDING FOR RESISTANCE TO VIRUS YELLOWS
1962

J. S. McFarlane, C. W. Bennett, and I. O. Skoyen

SELECTING FOR YELLOWS RESISTANCE

Selections for yellows resistance were made at Salinas from beets planted April 9 and July 2. The plantings were made in checkerboard arrangements so that each plant occupied an area 28 x 28 inches. The April planting was inoculated on May 31 and the July planting on August 28, using a combination of beet and western yellows. Aphid populations were high and natural infection with both mosaic and yellows occurred prior to inoculation. Natural infection was most severe in the July planting.

Included in the April planting were yellows-resistant selections from US 75, yellows-resistant selections from type O open-pollinated lines, selections from hybrids between European yellows-resistant lines and USDA curly-top-resistant lines, selections from a yellows-resistant American Crystal inbred and USDA curly-top-resistant lines, and selections from yellows-resistant lines developed entirely from USDA breeding material. The various lines differed markedly in the severity of yellowing and also in size of root. A total of 682 roots were selected from 28 segregating populations grown on 1.2 acres.

The July planting was from seed of yellows-resistant lines selected in November 1961. Greatest emphasis was placed on improving the resistances of segregating populations from crosses between European yellows-resistant lines and curly-top-resistant USDA lines. Foliage symptoms were relatively uniform and selections were based entirely on root size. A total of 337 roots were selected from 1.3 acres of sugarbeets.

RESULTS OF 1962 YELLOWS RESISTANCE EVALUATION TESTS[1]

Prior to 1962 all yellows resistance evaluation testing was done at Salinas, but results were often unreliable because noninoculated check plots could not be maintained free of virus infection. The warm, interior valleys of California offer a better opportunity to obtain accurate results, because aphid populations drop to a low level during the hot summer months and spread of yellows usually is not a problem, provided planting is delayed until May. In 1962 arrangements were made with the University of California to do a portion of the evaluation work on the University farm at Davis.

Plans and Procedures

Salinas Test

The Salinas evaluation test was planted April 5 to determine the resistance of six varieties and selections to beet yellows and beet western yellows. The treatments, consisting of a noninoculated check, a beet-yellows inoculation, and a western-yellows inoculation were arranged in randomized strips across each of five replications. The variety subplots were two rows wide and 35 feet long. The entire planting was sprayed with Thiodan at weekly intervals, beginning as soon as the beets emerged and continuing through June. Inoculations were made May 31 with virulent strains of beet-and western-yellows viruses. The test was harvested October 4.

Davis Tests

Evaluation tests were planted on the University farm at Davis on

[1]The assistance of Dr. L. D. Leach and Dr. F. J. Hills of the University of California in arranging and caring for the Davis test is gratefully acknowledged.

May 8. One test was designed to determine the resistance of six varieties and selections to both beet and western yellows. The treatments, consisting of a noninoculated check, a beet-yellows inoculation, a western-yellows inoculation, and a combination beet and western-yellows inoculation were arranged in randomized strips across each of four replications. The variety subplots were two rows wide and 40 feet long. Inoculations were made June 26 with the same virus strains used at Salinas.

A second test of nine hybrids and twenty inbreds was planted in the same manner to determine resistance to western yellows. The tests were harvested October 25-26.

Description of varieties and selections tested at Salinas and Davis.

US 75 -- Open-pollinated variety combining resistance to bolting and curly top.

011 -- Fourth successive beet-yellows resistant selection from US 75.

119 -- Beet-yellows resistant selection from increase of cross between American Crystal 55-RF393 and type-O 671.

028 -- Beet-yellows resistant selection from IRS 55M14 obtained from Instituut voor Rationele Suckerproductie, Bergen op Zoom, The Netherlands.

US H6 -- Commercial hybrid with parentage (MS of NB1 x NB5) x 663.

163H5 -- Monogerm hybrid with parentage (515HO x 569) x 663.

1539H1 -- Monogerm hybrid with parentage (515HO x 569) x NB7.

Description of hybrids tested for western-yellows resistance at Davis are in Table 6.

Results

High percentages of infection were obtained in all inoculated plots at both Salinas and Davis. Heavy flights of aphids entered the Salinas test during the early part of the growing season and infection with yellows could not be prevented even though the beets were sprayed weekly with an aphicide. Failure to control spread of yellows to the noninoculated plots affected the accuracy of the Salinas results. No yield reduction occurred in the plots inoculated with western yellows, so these data were omitted from the analyses.

In the Davis tests there was very little yellows spread to the noninoculated beets but irregular stands were a problem in many plots. Yield determinations in the open-pollinated and hybrid material were from corrected stands obtained by adjusting for missing feet of row. Stands were especially poor in the inbred lines, and these plots were abandoned except for observations of yellowing and stunting.

Root yields were relatively low at Salinas, ranging from 14.8 to 20.0 tons per acre in the noninoculated plots (Table 1). These low yields were caused in part by natural infection with yellows, much of which occurred during early stages of growth. Root yields at Davis ranged from 25.5 to 40.6 tons per acre in the noninoculated plots and were unusually high considering the short five-month growing season (Table 3). Sucrose percentages were low at both locations.

Root yield losses from beet yellows ranged from 6.7 to 21.2 percent at Salinas and from 20.1 to 32.1 percent at Davis (Tables 2 and 4). Differences between varieties in percent yield loss were not significant at either location, but the relative rank of the varieties was similar in the two tests. The high experimental error in the

Table 1. Effect of beet yellows on the performance of sugarbeet varieties and selections at Salinas, California, in 1962.

Treatment	Variety or Selection						
	US 75	011	119	US H6	163H5	1539H1	Ave.
Gross Sugar Yield in Pounds per Acre							
Check	3970	4690	4970	5090	5640	5820	5030
Beet yellows	3190	4240	4730	4090	4660	5090	4330
Average	3580	4470	4850	4590	5150	5450	

LSD (.05) for varieties (average of both treatments)=599
LSD (.05) for treatments (average of all varieties)=290

Treatment	US 75	011	119	US H6	163H5	1539H1	Ave.
Root Yield in Tons per Acre							
Check	14.8	16.9	18.0	17.6	19.4	20.0	17.8
Beet yellows	11.6	15.0	16.8	15.1	16.4	17.4	15.4
Average	13.2	16.0	17.4	16.3	17.9	18.7	

LSD (.05) for varieties (average of both treatments)=2.3
LSD (.05) for treatments (average of all varieties)=0.9

Treatment	US 75	011	119	US H6	163H5	1539H1	Ave.
Percent Sucrose							
Check	13.5	13.9	13.8	14.5	14.5	14.6	14.1
Beet yellows	13.8	14.1	14.1	13.6	14.2	14.6	14.1
Average	13.6	14.0	13.9	14.1	14.4	14.6	

Calculated F values are not significant for either varieties or treatments.

yield loss determinations can be attributed to the poor stands at Davis and to the yellows contamination in the noninoculated plots at Salinas. The relatively low losses observed from beet yellows at Salinas are misleading because the noninoculated checks were actually 100 percent infected with naturally occurring virus. The predominant virus in the Salinas area is thought to be western yellows and it is probable that most of the infection in the noninoculated plots was with this virus. By adding ten percent, which is approximately the loss expected from western yellows, to the Salinas yield reduction percentages,we arrive at losses similar to those experienced at Davis.

Table 2. Reduction in root yield of sugarbeet varieties and selections when inoculated with beet yellows at Salinas, California, in 1962.

Variety	Description	Reduction in yield Percent
US 75	Open-pollinated variety	21.2
011	Yel. res. sel. from US 75	11.5
119	Yel. res. selection	6.7
US H6	(MS of NB1 x NB5) x 663	14.7
163H5	(515HO x 569) x 663	15.2
1539H1	(515HO x 569) x NB7	12.9

Calculated F value = 2.58. Required F value (.05) = 2.71.

Root yield losses from western yellows ranged from 4.5 to 17.1 percent in the two Davis tests (Tables 4 and 6). Differences between varieties were not significant in either test. Losses from western yellows were approximately one-third of the losses from beet yellows. Very little yellowing or stunting occurred in plots inoculated with western yellows. Symptoms on lines such as 554H1 and 509H1 were so

Table 3. Effect of western yellows, beet yellows, and the combination of beet and western yellows on the performance of sugarbeet varieties and selections at Davis, California, in 1962.

	Variety or Selection						
Treatment	US 75	011	119	028	US H6	1539H1	Ave.
Gross Sugar Yield in Pounds per Acre							
Check	8510	8760	9630	6870	9870	9490	8860
Western yellows	7520	7950	9120	6210	8650	8990	8070
Beet yellows	5790	6810	7720	5560	7090	7270	6710
Beet & western yellows	4510	5900	6830	4610	5920	6490	5710
Average	6580	7350	8330	5810	7890	8060	

LSD (.05) for varieties (average of all treatments)=716
LSD (.05) for treatments (average of all varieties)=361

Root Yield in Tons per Acre							
Check	34.1	33.9	37.7	25.5	38.4	37.5	34.5
Western yellows	29.8	31.4	35.4	23.6	33.8	35.8	31.6
Beet yellows	23.1	26.0	30.2	20.3	27.3	28.4	25.9
Beet & western yellows	19.4	23.9	27.7	18.3	24.1	26.6	23.3
Average	26.6	28.8	32.7	21.9	30.9	32.1	

LSD (.05) for varieties (average of all treatments)=2.8
LSD (.05) for treatments (average of all varieties)=1.3

Percent Sucrose							
Check	12.5	13.0	12.8	13.5	12.9	12.7	12.9
Western yellows	12.6	12.6	12.9	13.2	12.8	12.6	12.8
Beet yellows	12.5	13.1	12.8	13.7	13.0	12.8	13.0
Beet & western yellows	11.7	12.3	12.3	12.6	12.3	12.2	12.2
Average	12.3	12.8	12.7	13.2	12.8	12.6	

LSD (.05) for varieties (average of all treatments)=0.3
LSD (.05) for treatments (average of all varieties)=0.5

Table 4. Reduction in yield and sucrose percentage of sugarbeet varieties and selections when inoculated with western yellows, beet yellows, and the combination of beet and western yellows viruses at Davis, California, in 1962.

Treatment	US 75	011	Variety or Selection 119	028	US H6	1539H1	LSD (5%)
Percent Reduction in Gross Sugar							
Western yellows	11.2	8.8	4.7	9.6	12.2	4.5	NS
Beet yellows	31.6	21.7	20.0	19.0	28.0	23.4	NS
Beet & western yellows	46.8	32.3	28.9	32.9	40.1	31.5	8.3
Percent Reduction in Yield of Roots							
Western yellows	12.5	6.5	5.6	7.3	11.9	4.4	NS
Beet yellows	32.1	22.7	20.1	20.3	28.8	24.2	NS
Beet & western yellows	43.2	29.1	26.5	28.0	37.3	28.9	7.4
Percentage Points Reduction or Gain in Sucrose							
Western yellows	+.14	-.31	+.11	-.31	-.08	-.10	NS
Beet yellows	-.07	+.15	+.03	+.21	+.12	+.12	NS
Beet & western yellows	-.80	-.62	-.44	-.89	-.57	-.49	NS

Table 5. Effect of western yellows on the performance of sugarbeet hybrids at Davis, California, in 1962.

Treatment	Hybrid 511H1	509H1	554H1	547H1	US H2	US H5	163H5	Ave.
Gross Sugar Yield in Pounds per Acre								
Check	9180	9400	10480	8270	9990	9660	10140	9590
Western yellows	7910	8300	9450	7320	8430	8130	8030	8230
Average	8540	8850	9970	7800	9210	8890	9090	
LSD (.05) for varieties (average of both treatments)=703								
LSD (.05) for treatments (average of all varieties)=541								
Root Yield in Tons per Acre								
Check	35.2	35.6	40.6	32.2	38.5	37.8	37.8	36.8
Western yellows	30.0	31.7	37.4	28.0	32.6	32.0	31.1	31.8
Average	32.6	33.7	39.0	30.0	35.6	34.9	34.4	
LSD (.05) for varieties (average of both treatments)=3.2								
LSD (.05) for treatments (average of all varieties)=2.3								
Percent Sucrose								
Check	13.1	13.2	12.9	12.9	13.0	12.8	13.5	13.0
Western yellows	13.2	13.1	12.7	13.1	12.9	12.8	12.9	13.0
Average	13.1	13.2	12.8	13.0	12.9	12.8	13.2	
Calculated F values are not significant for either varieties or treatments.								

Table 6. Reduction in root yield of sugarbeet hybrids when inoculated with western yellows at Davis, California, in 1962.

Variety	Description	Reduction in yield Percent
511H1	MS of NB1 x NB2	14.5
509H1	MS of NB1 x NB3	10.7
554H1	MS of NB1 x NB4	7.5
547H1	MS of NB1 x NB5	13.3
US H2	(MS of NB1 x NB3) x 663	15.3
US H5	(MS of NB1 x NB4) x 663	15.3
163H5	(515HO x 569) x 663	17.1

Calculated F value = 1.24. Required F value = 2.66.

mild that detection required a close observation of individual leaves. Yield losses were demonstrated even though the symptoms were mild.

The combination of beet and western yellows caused root yield losses ranging from 28.9 to 46.8 percent and these differences between varieties were significant at the five-percent level (Table 4). The losses caused by the virus combination were approximately equal to the sum of the losses from the viruses occurring singly. The selection 011 was damaged 29.1 percent by the virus combination, whereas the parent US 75 was damaged 43.2 percent. Losses in the yellows-resistant selections 119 and 028 were similar to those in 011. The monogerm hybrid 1539H1 showed significantly less damage than did either US 75 or US H6.

When data from all treatments in the Davis test were averaged, the selection 011 yielded 28.8 tons per acre with 12.8 percent sucrose compared to a yield of 26.6 tons and 12.3 percent sucrose for the parent US 75 variety. At Salinas, 011 yielded 16.0 tons with 14.0 percent sucrose, compared to 13.2 tons and 13.6 percent sucrose for US 75. The sucrose percentage of 011 was significantly higher than that of US 75 at Davis, and the root yield was significantly higher at Salinas.

The 119 selection was significantly superior to US 75 in both root yield and sucrose percentage in the Davis test. At Salinas, 119 yielded significantly higher than US 75. The performance of 119 was equal to that of US H6 and 1539H1 at both Salinas and Davis. 028, the yellows resistant selection from The Netherlands, had a significantly higher sucrose percentage than all other entries but was 4.6 tons lower in root yield than any other entry in the Davis test.

Beet yellows or western yellows had no significant effect on sucrose percentage in any of the tests. The sucrose percentage of beets inoculated with the combination of beet and western yellows was significantly lower than that of the beets from the other treatments, but losses were similar for the six varieties (Tables 3 and 4). A significant difference in root and gross sugar yields was demonstrated among all treatments in both the Salinas and Davis tests. The interaction between varieties and treatments was not significant in any of the tests.

Conclusions

Results of three years' testing with a yellows-resistant selection from US 75 demonstrate that improvements in resistance can be made by selecting in the field on the basis of root size from plants inoculated with yellows. The danger of quality deterioration is associated with a selection method based primarily on root size, but results with the fourth successive selection from US 75 demonstrate that a decrease in sucrose percentage need not necessarily occur.

The effects of yellows infection on sucrose percentage varies greatly from one test to another. Loss in root yield is a more accurate measure of resistance than is loss in sucrose percentage.

Losses from western yellows occur even when symptoms are barely distinguishable. Differences observed among varieties and selections have not been statistically significant, but it is probable that differences actually do exist. Losses from the western-yellows strain used in the 1962 tests caused an average loss of only about ten percent. Differences in resistance among varieties probably are relatively small, and exceptionally uniform test plots will be required to prove that differences exist.

Results of 1961 and 1962 tests indicate that selections made for resistance to beet yellows also show an improvement in resistance to western yellows.

The resistance of selections from the Salinas yellows resistance breeding program is equal to that of selections obtained from European breeders.

Resistance to yellows is determined by comparing the performance of inoculated and noninoculated plots. Salinas has proved to be an unsatisfactory location to make these comparisons because the non-inoculated plots can not be maintained free of infection. Results of 1962 tests at Davis indicate that resistance evaluation tests can be satisfactorily performed on the University farm. Plans are underway to expand the testing program at Davis.

PART XI

RHIZOCTONIA INVESTIGATIONS

Selecting for Resistance and Utilization
of Inoculation Techniques

Foundation Project 25

J. O. Gaskill

Research conduction in cooperation with the Botany and Plant Pathology Section, Colorado Agricultural Experiment Station.

RHIZOCTONIA INVESTIGATIONS,FORT COLLINS, COLORADO, 1962 1/

(A phase of Beet Sugar Development Foundation Project 25)

John O. Gaskill

The program of sugarbeet selection and progeny evaluation for Rhizoctonia resistance, under field conditions, continued to receive major emphasis during 1962. An exploratory trial of a greenhouse method of testing sugarbeet strains for resistance was conducted. The greenhouse technique also was used to test the resistance of a number of *Beta vulgaris* and *B. maritima* introductions.

Greenhouse Experiments

Comparison of Sugarbeet Strains.

A number of progenies that showed promise in 1961 field tests (1) 2/ were retested in the greenhouse early in 1962 by means of a technique involving the use of an artificial (sand-peat moss) soil for growing the plants (2). The seed was planted in 6" pots, in a circle 4 inches in diameter, and the seedlings were thinned to 8 per pot 7 days before the date of inoculation. Dry, ground barley grain inoculum of a highly pathogenic isolate (B-6) of *Rhizoctonia solani* was used to inoculate all pots when the plants averaged about 4 true leaves. A measured amount of inoculum

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1/ A progress report on investigations conducted by the Crops Research Division, Agricultural Research Service, U.S.Department of Agriculture, in cooperation with the Colorado Agricultural Experiment Station, the Beet Sugar Development Foundation, and the Board of County Commissioners of Larimer County.

2/ Numbers in parentheses refer to Literature Cited.

was placed in a small hole in the center of the plant circle in each pot and covered with the artificial soil. In order to minimize mechanical injury to the plant roots, the hole was made by imbedding a small glass vial in the soil, to a depth of 3/4 inch, in the center of the circle of seed at time of planting. The vial was carefully removed from the soil at the time of inoculation (Feb. 26, 1962). After inoculation, the pots were held at relatively high temperatures inside a chamber having walls and cover made of transparent polyethylene sheeting.

The sugarbeet strains tested included 9 progenies of roots that had been selected for resistance to Rhizoctonia. All 9 progenies were tested for resistance in the field in 1961 and showed enough evidence of resistance to warrant further testing (1). Four had been derived by selection at Ft. Collins, and one of these (SP 611107-0) had appeared especially promising in 1961. The other five were Great Western Sugar Company numbers, 5954-2, -92, -96, -145, and -186. Parental and check varieties were included in the test, making a total of 16 entry numbers, each of which occurred in 5 pots. A randomized-block design was used.

On April 9, 6 weeks after inoculation, the majority of the plants of each entry were dead or obviously diseased. Of the 640 plants in the entire experiment, only 8 were alive on August 3. These 8 plants represented 7 entries, 3 of which were parental or check varieties.

Under the extremely severe Rhizoctonia exposure in this experiment, there was no evidence of differing resistance among the strains tested.

Test of Foreign Introductions.

Ten introductions of B. vulgaris and 18 of B. maritima were compared with two sugarbeet varieties in a greenhouse test similar to that described (p. 312). There were 3 pots of each of the introductions and 6 pots of each sugarbeet variety. The B. vulgaris introductions were chosen as the least susceptible in a set of more than 200 such entries in a field test conducted in 1960 (3). The B. maritima material had not been tested previously for Rhizoctonia resistance.

On April 9, 6 weeks after inoculation, the majority of the plants of each introduction and of each sugarbeet variety were dead or obviously diseased. Only 2 plants in the entire experiment were alive on August 3. Both these plants were in one pot representing a single B. maritima introduction, P.I. 260310. Only one appeared healthy (foliage).

Under the very severe conditions of this test, there was no evidence that any of the introductions possessed a measurable degree of resistance to Rhizoctonia. However, the healthy appearing B. maritima plant was saved and is to be brought to seed.

Field Trials

Experiment R-1:

The principal field experiment (R-1) in 1962 involved comparison of 12 sugarbeet strains for Rhizoctonia resistance under two sets of conditions: (a) inoculum applied to the sugarbeet crop in the preceding year, and (b) inoculum applied after thinning in 1962 (semi-circle, sub-surface method). In the former, a single Rhizoctonia isolate (B-6) was used. In the latter, two isolates were employed separately, using 2 rates of application. These

isolates were numbers B-6 and 396-4. They were labeled A and B, respectively, for use in this study. Both were considered highly pathogenic.

The sugarbeet strains included parental and check material, progenies of roots selected for Rhizoctonia resistance at Ft. Collins, and a variety (A339) which had been developed by Dr. M. M. Afanasiev of Montana State College by selection for resistance. SP 621110-0 was derived largely from roots selected in the Great Western Sugar Company 5954 lines which, in turn, had resulted from root selections made by the Company under natural Rhizoctonia conditions in commercial fields of GW 602.

The roots giving rise to SP 621113-0 and SP 621114-0 were selected in 1961 in field plots at Ft. Collins where post-thinning methods of inoculation had been used that year. All other SP strains designated as "Rhizoctonia resistant selections" were produced by roots that had been selected at Ft. Collins under extremely severe field exposure to the disease resulting from residual inoculum -- i.e., Rhizoctonia remaining alive in the soil approximately one year after the time of inoculation.

Randomized-block design was used. In section b, main plots consisted of isolate and rate combinations with strains as sub-plots. The individual inoculated plot units in sections a and b were 1 row x 14' and 1 row x 16', respectively. The crop was planted June 26-27 and hand thinned to approximately 9" spacing at the usual stage of plant development. Further details regarding experimental design and procedure are given in the accompanying tables.

Where exposure to Rhizoctonia resulted from residual inoculum, disease losses were moderately severe, and highly significant differences occurred between sugarbeet strains, both in percentage survival and in yield of roots (Table 1). The outstanding performance of SP 611107-0 is of special interest in view of the fact that it also was outstanding under conditions of severe (but not extreme) Rhizoctonia exposure in 1961 (1). In the 1962 experiment (Table 1), SP 611107-0 exceeded the parental variety, GW 674, by highly significant amounts, both in percentage survival and in yield of roots. No explanation is proposed for the significant drop in yield shown by the 2 progenies of SP 611107-0 (i.e. SP 621113-0 and SP 621114-0). However, it should be noted that, in spite of this drop, both of these strains were significantly above the commercial parental variety (GW 674) in surviving stand, and both were above that variety in root yield --one significantly so. In this connection it also should be noted that the performance of GW 674 in this instance, as in 1961, was at least equal to that of the closely related commercial variety, GW 602. Selection for resistance in varieties other than GW 674 apparently was ineffective, according to the 1962 results (Table 1).

Under the extremely severe exposure created by post-thinning inoculation in 1962 (Tables 2 and 3), less than 1 percent of the entire inoculated stand was alive at harvest. Variance analyses of the results were not feasible, and differences between sugarbeet strains appeared to be largely due to chance.

<u>Experiment R-2</u>:

The material compared in Experiment R-2 consisted largely of Great

Western Sugar Company 5954 lines which had not been tested previously at Ft. Collins. Additional material included two sugarbeet varieties and two heterogeneous strains produced by making mass increases of roots of miscellaneous biennial B. vulgaris introductions that had been selected under severe Rhizoctonia conditions in 1960. The 20 entries occurred in two or four plots each. Experimental techniques and timing were similar to those described for section b of Experiment R-1, except that only one Rhizoctonia isolate (B-6) and one rate were used. Stands generally were good at time of inoculation (July 31). Rhizoctonia attack was extremely severe, and not one plant remained alive at harvest (Oct. 11).

Discussion and High Lights

As indicated above and in Tables 1, 2, and 3, post-thinning inoculation performed in 1962 resulted in almost complete loss of stand in experiment R-1, but in contrast, stand losses under conditions of residual inoculum were much less severe. The reverse was true in 1961 (1). This contradictory behavior in the two years is attributed largely to differing climatic conditions as related to overwintering of Rhizoctonia inoculum in the field and development of the fungus during the growing season following post-thinning inoculation. Except for moisture and temperature, soil differences were thought to be of minor importance.

In comparisons between parental material and progenies of roots selected for Rhizoctonia resistance, SP 611107-0 was outstanding under moderately severe disease exposure in 1962 (Table 1), supporting the results obtained under somewhat more severe exposure in 1961 (1). However, the

level of Rhizoctonia resistance or tolerance, apparently possessed by SP 611107-0, was not sufficient to provide any measurable degree of protection under extremely severe conditions in the field (Tables 2 and 3) or in the greenhouse.

There was no evidence of resistance among the foreign introductions of *B. vulgaris* and *B. maritima*, compared in the greenhouse under extremely severe Rhizoctonia conditions.

Literature Cited

(1) Gaskill, John O. Rhizoctonia investigations, Fort Collins, Colorado, 1961. Sugar Beet Research, 1961 Report (CR-4-62): 330-337.

(2) Pierson, Victor G., and John O. Gaskill. 1961. Artificial exposure of sugar beets to *Rhizoctonia solani*. J. Am. Soc. Sugar Beet Technol. 11:574-590.

(3) Schneider, C. L., and John O. Gaskill. 1962. Tests of foreign introductions of *Beta vulgaris* L. for resistance to *Aphanomyces cochlioides* Drechs. and *Rhizoctonia solani* Kuehn. J. Am. Soc. Sugar Beet Technol. 11:656-660.

Table 1. -- Comparison of sugarbeet strains for resistance to Rhizoctonia, Ft. Collins, Colorado, 1962; inoculation performed in preceding year; results given as 10-plot averages.

Description	Ft. Col. seed no.	Stand: Thin. a/	Stand: Harv. b/	Total c/ wt. of roots
		No.	%	Lbs.
SP 5831-0; LS-BR res. var.; mm	Acc. 2233	19.4	77.2	9.82
Rhizoc. res. sel. from SP 5831-0	SP 621107-0	18.7	74.9	7.31
LS-BR resistant var.; mm	SP 601000-0	18.5	77.3	9.60
Rhizoc. res. sel. from SP 601000-0	SP 621118-0	19.3	78.3	9.50
GW 602; LSR coml. var.; MM	Acc. 2475	18.4	62.3	9.80
Rhizoc. res. sel. from GW 602	SP 621110-0	18.9	67.1	9.90
GW 674-56C; LSR coml. var.; MM	Acc. 2168	19.1	62.4	10.37
Rhizoc. res. sel. from GW 674-56C	SP 611107-0	19.0	81.7	13.24
Rhizoc. res. sel. from SP 611107-0	SP 621113-0	19.0	76.8	11.28
Rhizoc. res. sel. from SP 611107-0	SP 621114-0	18.6	75.9	11.85
G.W.S. Co. A339 (Afanasiev's Rhizoc. res. sel., MM)	Acc. 2481	18.7	74.4	9.48
US 401; LS-BR res. com'l. var.; MM	Acc. 2057	18.9	62.9	9.34
General mean			72.61	10.124
LSD (5% point)			11.7	1.26
LSD (1% point)			15.5	1.67

a/ Living plants per plot (14' of row) on 7/20/62, immediately after thinning.

b/ Living plants at harvest (10/8/62) as percent of thinned stand.

c/ Total weight of roots of living plants per plot (14' of row) at harvest; crowns excluded.

Table 2. — Comparison of sugarbeet strains for resistance to Rhizoctonia, Ft. Collins, Colorado, 1962; inoculation performed after thinning; basic results given as 3-plot averages.

Description	Ft. Col. seed no.	Isolate, rate, & percentage survival [a]				
		Isolate A		Isolate B		aver-
		Heavy	Light	Heavy	Light	age
		%	%	%	%	%
SP 5831-0; LS-BR res. var.; mm	Acc. 2233	0.00	0.00	0.00	1.52	0.38
Rhizoc. res. sel. from SP 5831-0	SP 621107-0	0.00	0.00	0.00	3.18	0.80
LS-BR resistant var.; mm	SP 601000-0	0.00	0.00	0.00	0.00	0.00
Rhizoc. res. sel. from SP 601000-0	SP 621118-0	0.00	0.00	1.52	1.59	0.78
GW 602; LSR com'l. var.; MM	Acc. 2475	1.52	0.00	0.00	1.45	0.74
Rhizoc. res. sel. from GW 602	SP 621110-0	0.00	0.00	1.45	4.55	1.50
GW 674-56C; LSR com'l. var.; MM	Acc. 2168	0.00	0.00	0.00	7.58	1.90
Rhizoc. res. sel. from GW 674-56C	SP 611107-0	0.00	0.00	0.00	2.97	0.74
Rhizoc. res. sel. from SP 611107-0	SP 621113-0	0.00	0.00	1.45	4.48	1.48
Rhizoc. res. sel. from SP 611107-0	SP 621114-0	0.00	0.00	0.00	9.52	2.38
G.W.S. Co. A339 (Afanasiev's Rhizoc. res. sel., MM)	Acc. 2481	0.00	0.00	0.00	3.17	0.79
US 401; LS-BR res. com'l. var.; MM	Acc. 2057	0.00	0.00	0.00	1.52	0.38
General mean		0.13	0.00	0.37	3.46	0.99

a/ Percentage survival at harvest (10/11/62) based on stand at time of inoculation (7/30/62). Stand was good in all plots at time of inoculation, averaging 21.3 plants per plot (16' of row).

Table 3. — Comparison of sugarbeet strains for resistance to Rhizoctonia, Ft. Collins, Colorado, 1962; inoculation performed after thinning; basic results given as 3-plot averages.

Description	Ft. Col. seed no.	Isolate, rate, & root yield per plot a/				
		Isolate A		Isolate B		Average
		Heavy	Light	Heavy	Light	
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
SP 5831-0; LS-BR res. var.; mm	Acc. 2233	0.00	0.00	0.00	0.16	0.04
Rhizoc. res. sel. from SP 5831-0	SP 621107-0	0.00	0.00	0.00	0.30	0.08
LS-BR resistant var.; mm	SP 601000-0	0.00	0.00	0.00	0.00	0.00
Rhizoc. res. sel. from SP 601000-0	SP 621118-0	0.00	0.00	0.80	0.46	0.31
GW 602; LSR com'l. var.; MM	Acc. 2475	0.02	0.00	0.00	0.42	0.11
Rhizoc. res. sel. from GW 602	SP 621110-0	0.00	0.00	0.23	0.88	0.28
GW 674-56C; LSR com'l. var.; MM	Acc. 2168	0.00	0.00	0.00	2.13	0.53
Rhizoc. res. sel. from GW 674-56C	SP 611107-0	0.00	0.00	0.00	0.82	0.21
Rhizoc. res. sel. from SP 611107-0	SP 621113-0	0.00	0.00	0.18	1.22	0.35
Rhizoc. res. sel. from SP 611107-0	SP 621114-0	0.00	0.00	0.00	1.69	0.42
G.W.S. Co. A339 (Afanasiev's Rhizoc. res. sel., MM)	Acc. 2481	0.00	0.00	0.00	0.40	0.10
US 401; LS-BR res. com'l. var.; MM	Acc. 2057	0.00	0.00	0.00	0.19	0.05
General mean		0.002	0.000	0.101	0.723	0.207

a/ Root yield expressed as total weight of roots of living plants per plot (16' of row) at harvest, 10/11/62; crowns included.

PART XII

PHYSIOLOGICAL INVESTIGATIONS

Leaf Area in Relation to Size of Root

Effects of Indoleacetic Acid on Yield and Sucrose Percentage

F. W. Snyder

Research conducted in cooperation with Michigan Agricultural Experiment Station.

PHYSIOLOGICAL STUDIES - 1962[1]

F. W. Snyder

I. Leaf Area in Relation to Size of Sugarbeet Roots.

Uncompetitive plants were grown in tiles (See 1961 report) from open pollinated seeds of a single plant of US401 and from seeds of hybrid 62B1x05. Leaf areas were measured periodically on the living plants until they were harvested in October. Leaf area in June did not correlate significantly with either root weight or total plant weight at harvest. August leaf area correlated with either root weight or total plant weight at approximately 0.5 for both varieties.

The relatively low correlation between leaf area and root weight seems to be caused by genetic variation and not environmental variation. The data for two years show that some plants produce relatively large roots for a given leaf area, while others produce relatively small roots with the same amount of leaf area. Plants apparently have different potentials for root size as well as different potentials for developing leaf area. The various combinations of these potentials in a random sample of plants probably account for the apparent low correlation between leaf area and root weight.

II. Physiological studies which require the plants to grow for the full outdoor season have been seriously complicated by the enormous genetic heterogeneity within varieties. When experiments must be limited in size, the lack of a consistent pattern of performance of the plants within a treatment makes it almost impossible to interpret the effect of the treatments. Perhaps vigorous hybrids from nearly homozygous parents will perform consistently. (Inbreds are not satisfactory because they lack vigor.) A project designed to provide such plant material should aid greatly in fostering more productive physiological studies on sugarbeets.

1/ Research conducted in cooperation with Michigan Agricultural Experiment Station.

Effect of Indoleacetic Acid on Yield and Sucrose Percentage of Sugarbeets

Location of experiment: Michigan State University Farm, East Lansing, Mich.
Variety: Hybrid 62B1x010
Date planted: May 10, 1962 Date harvested: October 2, 1962
Fertilization: Broadcast approximately 950 pounds of 12-12-12 on surface of soil after seed was planted.
Experimental design: Randomized plots, 21 feet long, 4 rows wide (28" row width), 2 replications of each treatment. All rows harvested and weighed. This report based on data for rows 2 and 3 of each plot. IAA applied as foliar spray - maximum of 5 liters applied to a plot. Initial spraying on June 15.

Treatment	Number applications	Yield	Sucrose percentage
No treatment		24.1 T./A.	16.6
		Yield as % of "No treatment"	Sucrose as % of "No treatment"
25 ppm monthly	4	109.8	99.4
100 ppm monthly	4	100.0	93.4
100 ppm bimonthly	8	98.5	91.6
100 ppm Sept. 13, 26	2	103.9	96.4
400 ppm monthly	4	105.9	96.4
400 ppm Sept. 13, 26	2	107.8	93.4
1,000 ppm Sept. 13, 26 *	2	100.7	94.0

* Plants exhibited epinasty after treatment and at harvest on October 2.

None of the yields were significantly different at the 5% level. Except for the 25 ppm treatment, all treatments tended to reduce the sucrose percentage.

A single plot was planted in the above experiment in which seed that had been soaked for 15 hours in 30 ppm IAA was planted while wet. The yield was 100 percent of the control and the sucrose content was 103.0 percent of the control.

On single plots in the above design, N6 Benzyladenine was applied at 100 and 300 ppm on Sept. 13 and 26 and at 800 ppm on Sept. 26. (Volumes were adjusted to correct for limited solubility.) No significant differences in yield or sucrose percentage were found. No data on respiration were obtained.

PART XIII

DEVELOPMENT OF BASIC BREEDING MATERIAL

and

EXPERIMENTAL HYBRIDS

Foundation Project 26

G. E. Coe

DEVELOPMENT OF BREEDING MATERIAL THAT IS RESISTANT TO LEAF SPOT AND BLACK ROOT

G. E. Coe

Most research under Foundation Project 26 at the Plant Industry Station, Beltsville, Maryland, is directed toward varietal improvement in resist ance to Cercospora leaf spot and Aphanomyces black root. This research program contributed to the synthesis of many varieties, hybrids, and other items that were evaluated in field tests reported in Part IV of this Report.

The progress in the improvement of basic breeding lines during the past 7 years will be reviewed as a background to current accomplishments. Four major phases of breeding research will be presented: improvement in disease resistance, root yield, sugar percentage, and percentage soluble nonsugar constituents. The general improvement that has been achieved through selection and breeding procedures will be shown by graphs.

The graphs were prepared from a compilation of average values of all data from field tests at Beltsville, Maryland, and East Lansing, Michigan, on breeding lines whose last selection was made at Beltsville. Results from the nursery test at Waseca, Minnesota, were not included because erratic stands for some years rendered the data unsuitable for the present study. However, for years of reliable tests the various entries gave a performance at Waseca that more nearly conformed to the Beltsville tests than did the results from East Lansing.

Methods of Evaluation

Probably the reaction of progenies to the leaf spot pathogen Cercospora beticola is evaluated with greater reliability than the other characters to be discussed. The leaf spot evaluation tests were made at Beltsville, Maryland, where the disease occurs in epidemic proportions each year. In this report the relative resistance of progenies is given in relation to the damage caused by the disease on foliage of US 401. In tests of each year the disease damage in US 401 is taken as a base of 100; entries suffering more damage than US 401 would receive values less than 100; and, conversely, entries with less damage from disease than US 401 received values greater than 100. A progeny having disease tolerance halfway between immunity and that of US 401 would get a numerical rating of 150; therefore, the maximum numerical rating for resistance (short of immunity) would be 199. A progeny performing halfway between total loss of plants due to disease and that of US 401 would receive a numerical rating of 50; hence, performance ratings decrease with increase in damage from disease.

Other characters are rated in a similar manner in relation to the performance of US 401. High performance ratings for root yield and sugar percentage represent high tonnage and high sugar percentage, but high ratings for nonsugar solids represent low content of soluble nonsugar constituents.

Improvement in Disease Resistance

Leaf spot ratings of all multigerm progenies in nursery tests for 1955 through 1962 and black root ratings for 1956 through 1962 are given in Graph 1. The first greenhouse tests for black root resistance were conducted in 1956; therefore, there are no data for black root resistance for entries in the 1955 nursery tests.

The solid line in Graph 1 depicts the improvement in the performance of the multigerm varieties in resistance to Cercospora leaf spot. In 1955, the average performance of multigerm lines was 110, reflecting the improvement made since US 401 was produced in 1953. A performance rating of 128 was reached in 1962.

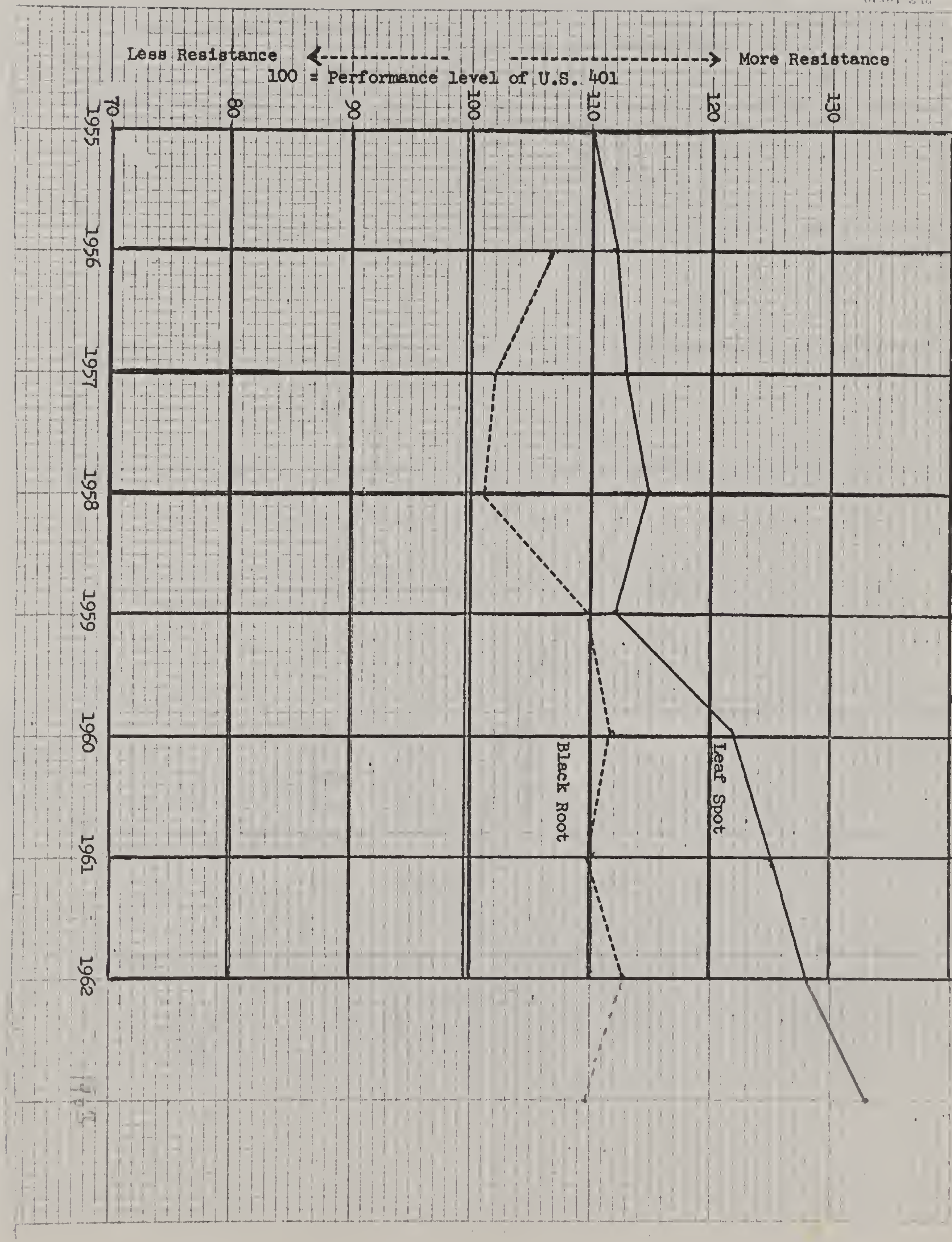
The dotted line in Graph 1 depicts the improvement in the performance of multigerm varieties in resistance to Aphamonyces black root. Only a few select multigerm progenies produced in 1955 were tested for black root resistance in the greenhouse, and none was eliminated from the nursery planting on the basis of this test; therefore, 1959 and 1960 were the first years wherein improvement could have become manifest from selections based on greenhouse tests for black root resistance. There appears to have been little or no improvement in 1961, but some increase in black root resistance was shown for 1962.

The average ratings of monogerm lines for resistance to leaf spot and black root are presented in Graph 2. The improvement of the monogerm lines in resistance to Cercospora leaf spot follows the same trend as shown for the multigerm lines in Graph 1. The monogerm and multigerm breeding material showed essentially the same level of leaf spot tolerance in 1962.

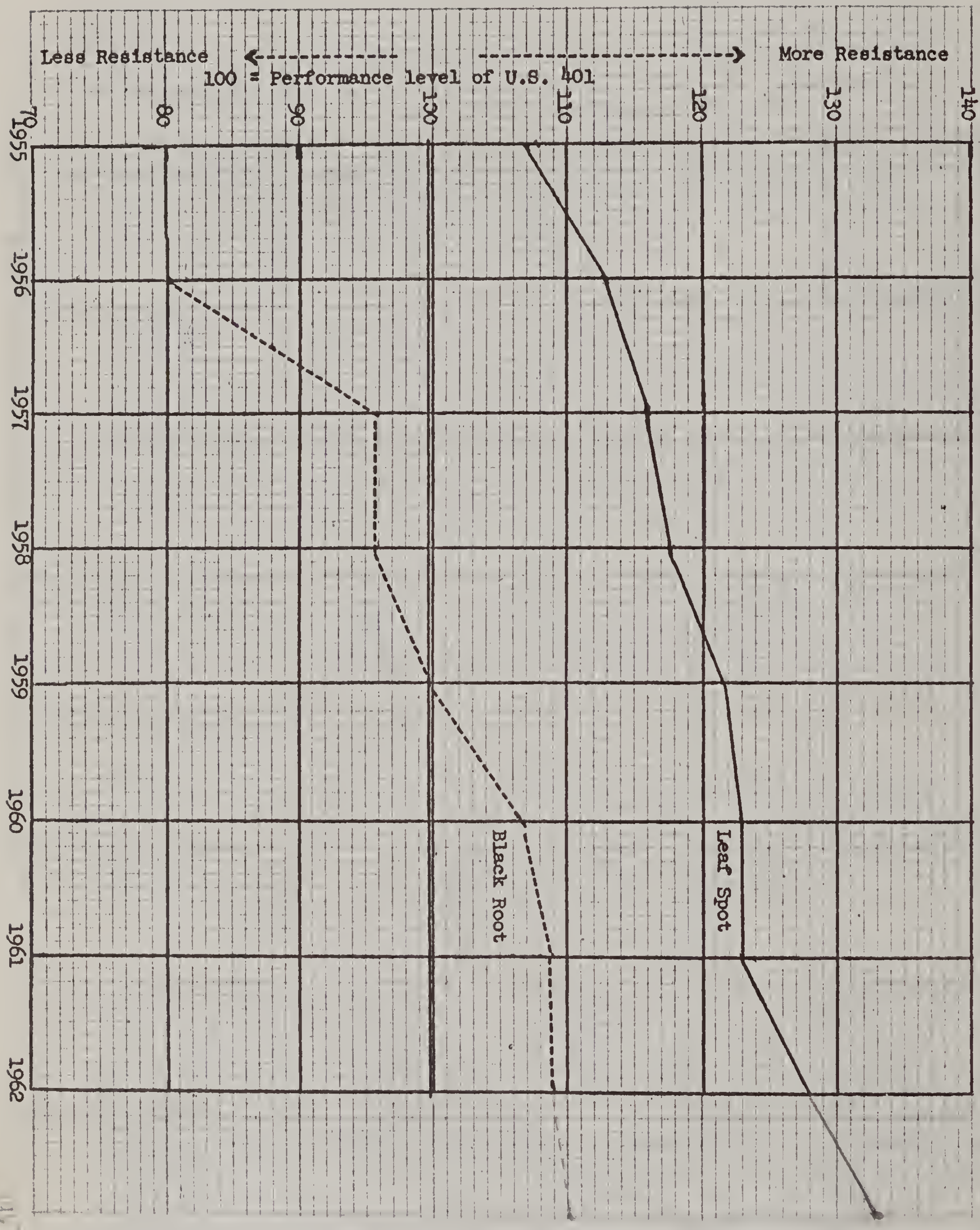
The improvement of the monogerm lines in resistance to black root has been more spectacular than that of the multigerm lines, primarily because they started with much less resistance and also because they have acquired resistance both by direct selection and from resistant multigerm lines as a result of backcrossing procedures.

Performance in Root Yield

The root tonnage performances of multigerm progenies are presented in Graph 3. In this graph the root tonnage of US 401 is taken as 100. Since most of the lines have been grown under their natural biennial cycle, the lines of descent in all graphs dealing with multigerm lines are continuous in alternate years. The selections of 1955 showed a decrease for root tonnage in tests of 1957. The 1956 selections in tests of 1958 indicated an improvement in root yield at Beltsville but a decrease in root yield at East Lansing. Since 1958, there has been some improvement in root tonnage performance. The good root yield performance of selections at Beltsville is undoubtedly related to improvement in leaf spot resistance and cannot be attributed entirely to enhancement of inherent yield potential.

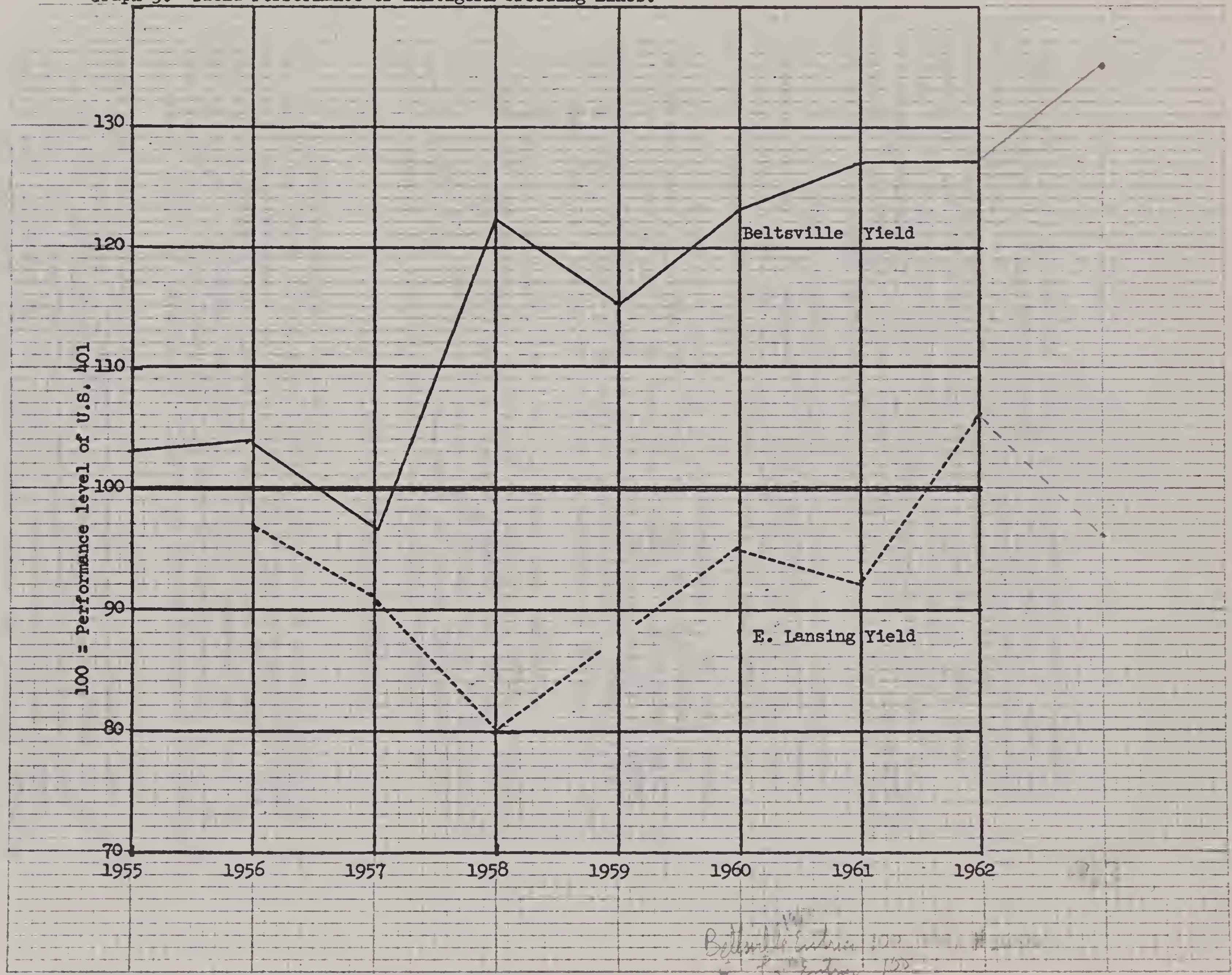


Graph 1. Disease resistance performance of multigerm breeding lines.



Graph 2. Disease resistance performance of monogerm breeding lines.

Graph 3. Yield Performance of multigerm breeding lines.



Graph 4 shows the root tonnage performance of monogerm lines. It can be seen that root tonnage of the new lines increased until 1959 but has fluctuated considerably since then. Marked improvement in monogerm lines previous to 1960 was expected, since the original monogerm parent was extremely low in vigor. Backcrosses to higher yielding multigerm lines have resulted in higher producing monogerm lines. In addition, the early monogerm lines had little resistance to leaf spot and black root. Improvement in resistance to diseases also is reflected in increased tonnage.

The outcrossing of the monogerm lines for the acquisition of desirable characters has varied greatly each year, and this accounts for some of the variation in tonnage ratings since 1959. Usually the level of tonnage performance can be roughly predicted from parentage. In contrast to the curves for multigerm lines, the root tonnage curve for monogerm lines at the East Lansing nursery is quite similar to the one from the Beltsville nursery.

Performance in Sugar Percentage

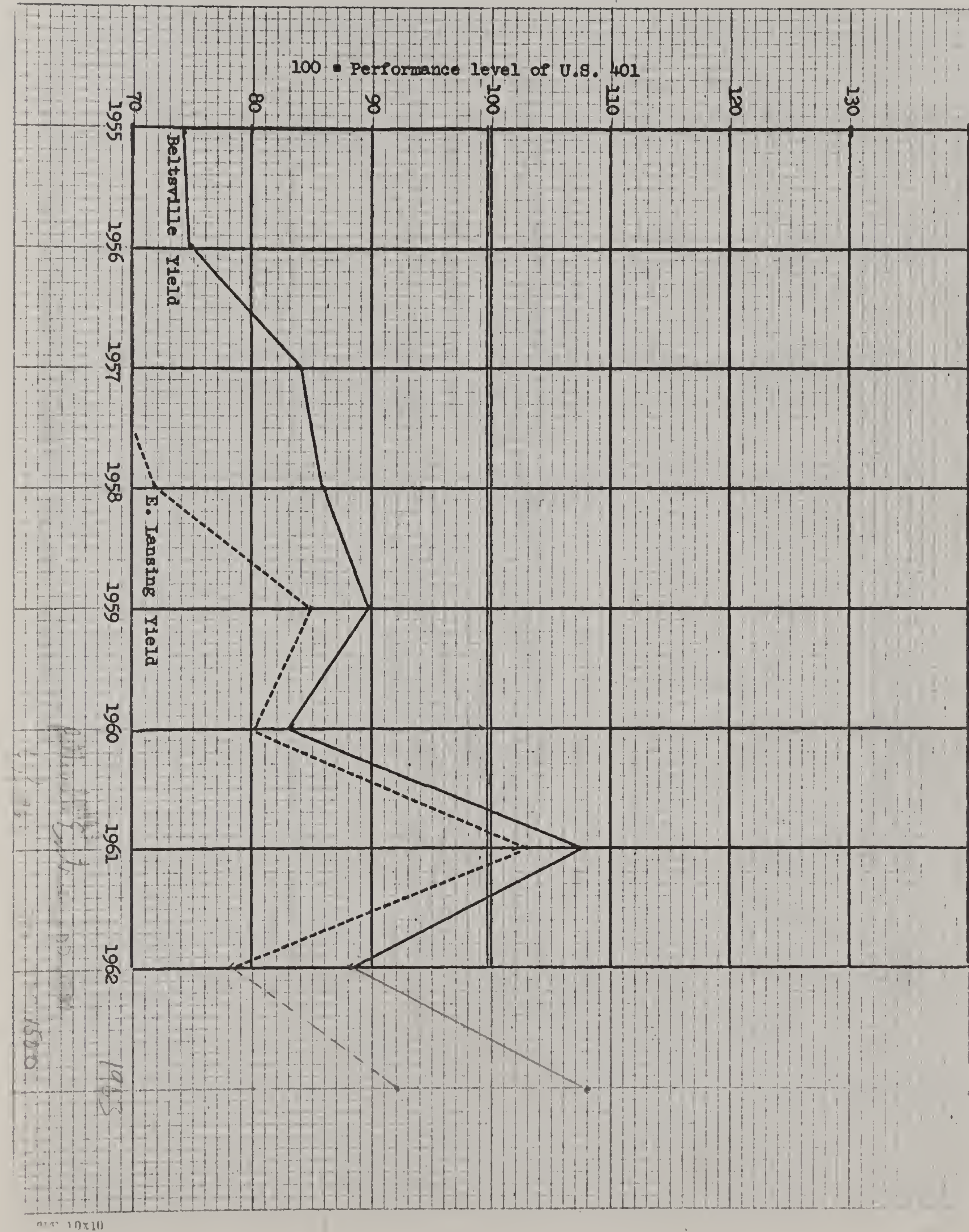
The performance of the multigerm lines in sugar percentage is presented in Graph 5. Two factors must be taken into consideration for a satisfactory explanation of sucrose performance at Beltsville: First, the inverse relationship between tonnage and percent sugar; and second, the beneficial effect of increased leaf spot resistance when tests are conducted under severe leaf spot exposure.

The trend toward a decrease in sugar percentage at Beltsville, from 1955 to 1960, is probably related to the increase in root yields. The fact that the multigerm breeding material was better in sugar percentage than US 401 is in part due to superior leaf spot resistance. The upward trend of sugar percentage in 1961 and 1962 might be attributed to selection pressure for improvement in this character.

The sugar percentage of the multigerm lines at East Lansing was essentially the same as for US 401, from 1956 to 1960. The performance in 1961 may represent actual improvement in this characteristic, or merely another expression of leaf spot resistance.

The sugar percentage of monogerm lines is presented in Graph 6. This character has remained rather constant for East Lansing, which may be an accomplishment, since one would expect improvement in root yield to result in a numerical reduction in sucrose percentage. At Beltsville, the sugar percentage curve is related to leaf spot damage. Performance ratings for sugar percentage at Beltsville has undoubtedly been influenced by improvement in leaf spot resistance. The high performance rating in 1960 is mostly a result of relatively low yield and not actual improvement in percent sugar.

Graph 4. Yield Performance of monogerm breeding lines.



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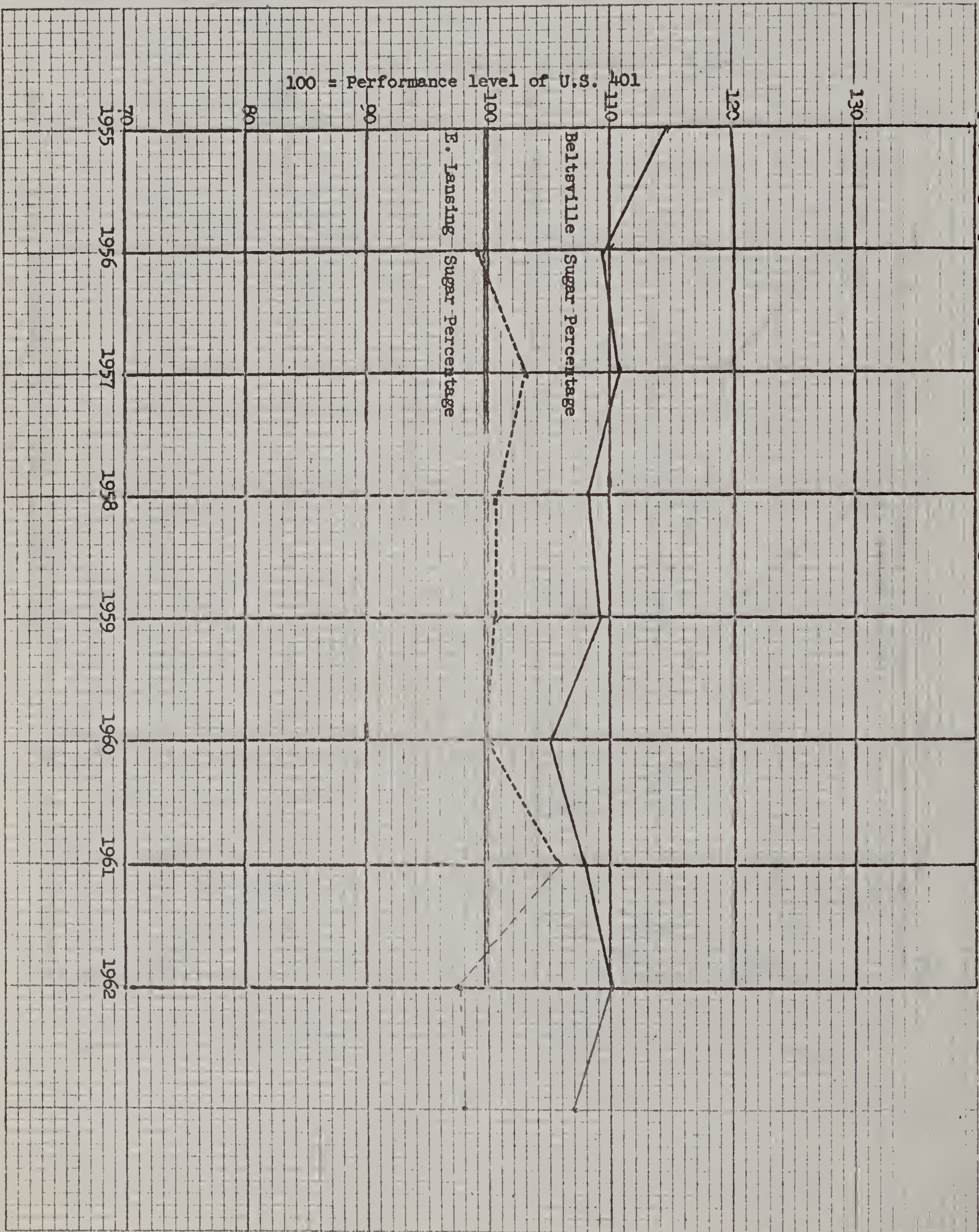
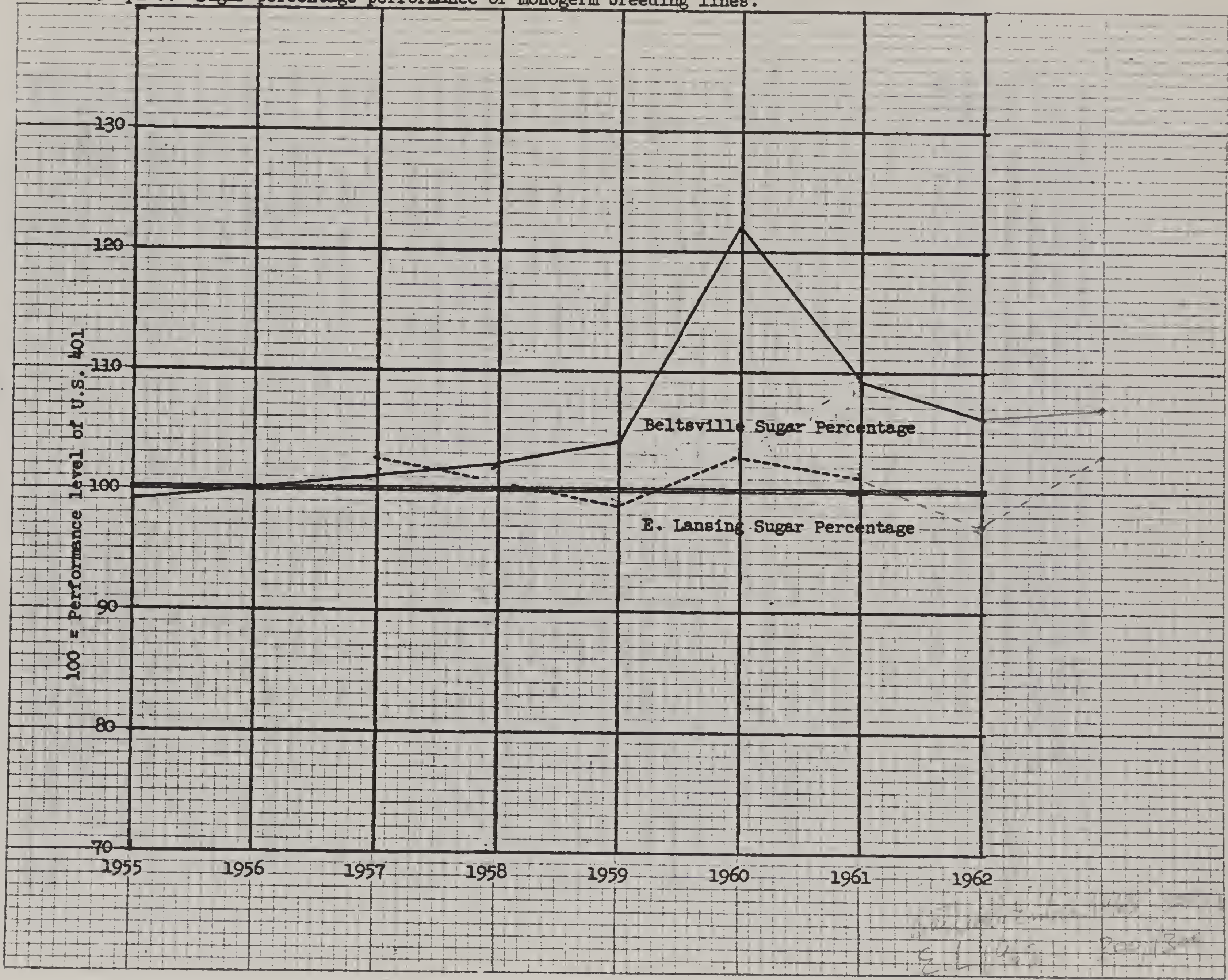


Graph 5. Sugar percentage performance of multigerm breeding lines.

Graph 6. Sugar percentage performance of monogerm breeding lines.



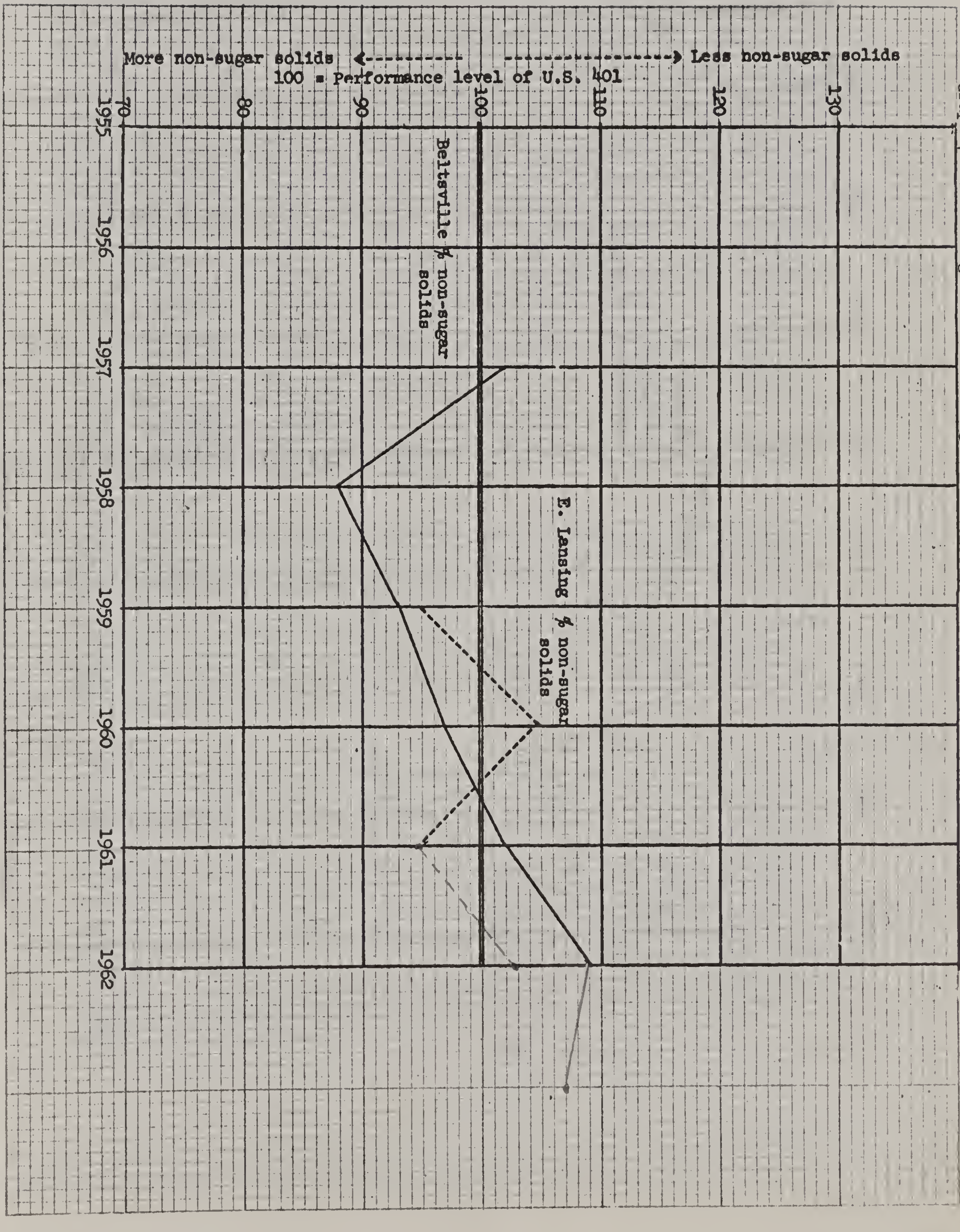
Performance in Nonsugar Constituents

Quality is influenced by sugar percentage as well as by concentration and kind of other soluble chemical constituents in the sugarbeet root. If sugar percentage can be increased or nonsugar constituents decreased, purity will be improved. It is difficult to properly evaluate the potential nonsugar solids of sugarbeet lines, because the concentration of the constituents are influenced by nutrition and environment as well as genetic factors. Selections for low nonsugar solids were included in the breeding program in 1957. This need was evident, because the monogerm lines have been high in soluble nonsugar constituents; and, consequently, they have performed rather poorly in this respect when compared with US 401. The performances of multigerm lines with respect to nonsugar solids are presented in Graph 7, and those of monogerm lines are presented in Graph 8. It appears that selection for this characteristic has resulted in some improvement.

It can be concluded that good progress has been made over a period of several years in increasing resistance of sugarbeet breeding lines to Cercospora leaf spot without any reduction in root yield or sugar percentage. Some progress has also been made in increasing resistance to black root. The multigerm breeding lines have more resistance than the monogerm lines. Although improvement has been made in root yield of monogerm breeding lines, as a group they are still below the multigerm lines in this character. Of course, this excludes monogerm-multigerm hybrids which often perform better than multigerm lines. Since the multigerm lines are superior to the monogerm lines in several desirable characters, the continued use of multigerm lines in the breeding program is imperative. The possibility of decreasing the concentration of soluble nonsugar constituents in the sugarbeet has been indicated in tests of multigerm lines at Beltsville, and this finding is being applied to monogerm breeding. It has not been possible to improve concomitantly all the characters for which selections are made, but some multigerm lines have shown improvement in leaf spot resistance, black root resistance, sugar percentage and lower nonsugar solids without any loss of root yield.

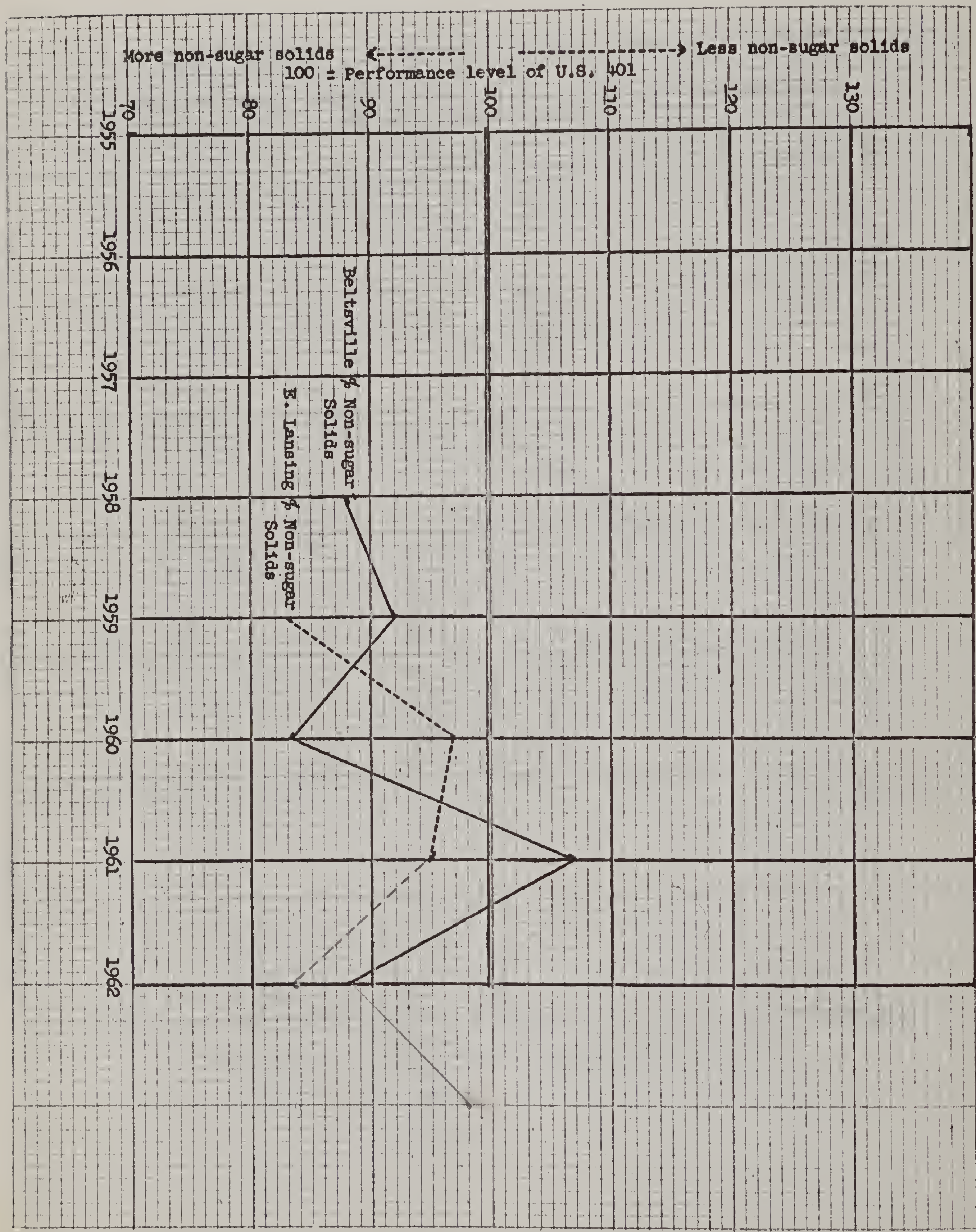
Some Noteworthy Varieties

Several varieties of sugarbeets that are resistant to leaf spot and black root have been developed in the breeding program at Beltsville with the assistance of cooperative field evaluations -- especially those conducted in Michigan and at Waseca, Minnesota. The greenhouse test for resistance to _Aphanomyces cochlioides_ developed by C. L. Schneider has been very effective in revealing black root resistant lines among the large number available for evaluation.



Graph 7. Percentage soluble non-sugar solids performance of multigerm breeding lines.

Graph 8. Percentage soluble non-sugar solids performance of monogerm breeding lines.



Excellent leaf spot resistance was established in SP 5460-0. This multigerm variety has been used as a pollinator in the production of commercial monogerm hybrids such as SL 122 MS X SP 5460-0. In some hybridizations, SP 5460-0 has shown good combining ability and tends to impart its leaf spot resistance to its hybrid variety.

SP 5822-0 is one of the most promising multigerm varieties produced at Beltsville. Although the potential root yield of SP 5822-0 is probably no greater than that of US 401, it is more resistant to leaf spot and black root, higher in sucrose percentage, and lower in soluble nonsugar constituents. The good performances of SP 5822-0 are shown on pages 129, 131, and 135 of this Report and on pages 104, 106, and 111 of the 1961 Report. The excellent leaf spot resistance and high sugar percentage and purity of SP 5822-0 are especially attractive. In preliminary evaluations SP 5822-0 has been superior to SP 5460-0 as a pollen parent in hybridizations.

The current varieties SP 6122-0 and SP 61151-0 are selections from SP 5822-0. Leaf spot resistance and root size were emphasized in the mother plants of SP 6122-0 and leaf spot resistance and low soluble nonsugar constituents in mother plants of SP 61151-0. It will be observed from leaf spot readings on page 96 and the results of field tests reported on pages 133 and 137 that the selections were effective.

Two open-pollinated monogerm varieties, SP 60194-01 and SP 60195-01, did not differ significantly from the multigerm check SP 5481-0 in root yield and sucrose percentage in the 1961 and 1962 trials. Both of these monogerm varieties were recovered from F_2's involving crosses of monogerm and multigerm lines. Except for the monogerm character the mother plants were unselected. SP 60195-01 has better leaf spot resistance than SP 60194-01, but the latter has better root yield.

The new monogerm varieties, SP 6161-0 and SP 61624-0, were included in the uniform variety tests summarized on page 99. The mean root yield and sucrose percentage of these monogerm varieties did not differ significantly from the values for SP 5481-0. SP 61624-0 is an open-pollinated variety recovered from F_2's without selection except for monogerm character. SP 6161-0 is a synthetic variety produced by the interpollination of six clones of plants whose open-pollinated progenies gave excellent performance at Beltsville and E st Lansing. Although the mean values for root yield and sucrose percentage of these two monogerm varieties are not significantly different from the values given for SP 5481-0, they are not sufficiently outstanding in any of the attributes to recommend their commercial use.

The monogerm male-sterile line SP 6123-01 MS mm was good as a female parent in some hybrids such as SP 62B1 X 09, SP 62B2 X 09 and SP 62B3 X 09. These hybrids were among the high performing ones in field tests at Beltsville and East Lansing.

The use of proper breeding methods, good testing techniques, and effective selection procedures will undoubtedly result in further improvement in the breeding lines and varieties with respect to disease resistance, quality, and yielding ability.